ACCIDENTS IN MINES.*

Fire Damp.

(*Continued from page 213.*)

During the last thirty-five years eruptions of firedamp which have been termed "sudden outbursts" and "instantaneous discharges" have been much more frequently observed. To these, which appear to become more numerous with the augmentation of depth in our own collieries and in those of Belgium, we consider it highly important to refer, partly in order to insist on the necessity of due preparation for their possible occurrence, and partly to instigate farther inquiry into their cause, with a view to their possible prevention or mitigation.

Numerous sudden outbursts have been described, especially those at the collieries of Walker, Jarrow, Haswell, and Hebburn, in which the eruption of gas was accompanied by the dislodgement of large quantities of coal, much of it in a disintegrated state (known as "danty" coal.) The clear description by Mr. G. Clark of two such cases which occurred in November, and December, 1846, from the Low Main coal at Walker Colliery, records that, in approaching a slip dyke, a quantity of small coal, amounting in one case to eleven tons, was violently projected into the workings, accompanied by a discharge of gas, which in the course of a few minutes fouled respectively 41,000 cubic feet and 86,000 cubic feet of the air passages. So good, however, was the discipline, and so prudent the behavior of those present, that although a terrible explosion seemed imminent and several of the Davy lamps became redhot, no accident happened.

We have received an account of an outburst from the Black Vein seam at Abercarne, which, though fortunately unattended with injury to those present, is remarkable on account of the quantity of gas given off. A heading was being driven through a hard portion of the seam and was approaching a region of softer coal when large masses of coal at the end of the heading were blown out and gas rushed into the workings with such force as to overthrow men and tubs. Though about 12,000 cubic feet of air per minute continued to pass the place where the outburst occurred, the neighboring parts of the workings were not sufficiently free from gas for four days for work to be continued. It was estimated that considerably more than a million cubic feet of gas came off.

One of the more recent outbursts is that which occurred at Celynen (Newport Abercarne) on November 11, 1880, of which full particulars were sent to the Commission by Mr. J. Green, the manager of the colliery. Whilst an airway, or narrow place of 9 feet wide, was being driven, an outburst took place so suddenly that one of the two men working in the face was buried in small coal, which, to the amount of about forty tons, was projected into the drift. A careful examination proved that the gas came neither from floor nor roof, but was pent up in the seam itself, the Black Vein.

In some instances it appears that a streak or patch of softer or disintegrated coal, or a slip-dyke or trouble, may be an indication of a possible discharge of gas; but this is by no means invariably the case.

It appears from a paper published in 1865 by the late M. De Vaux, that a number of sudden discharges of firedamp from the seams of coal in the deep pits of Belgium had already led to the recognition of a new source of danger. At that date only eighteen cases had been recorded; but M. Arnould in his valuable essay on the subject, cites forty-eight cases as having occurred between 1865 and 1879. Unhappily some of these were attended with great loss of life, as at the mine of L'Agrappe, at Frameries, in April, 1879, where 121 persons perished. The fulness of the details which M. Arnould has given, and his enumeration of the precautions to be taken in districts subject to this source of danger, render his book worthy of careful study.

Another form of outburst, in which gas breaks out from the roof or from the floor (*thill*) of the seams, had long ago been noticed in some few instances in the north of England. Serious attention was, however, first directed to this source of danger by a fatal accident at Shipley Colliery in August, 1851, and by several other cases, occurring a few years aftewards, both there and in South Yorkshire. On many occasions, happily, the men escaped and were able to relate how in a few minutes a large area of the workings was shown, by the behavior of their safety lamps, to be filled with an explosive mixture. In some instances the gas had died away in a few hours; in others, it continued to be given off for some months. Your Commissioners visited, on May 20, 1880, a part of the workings of the Strafford Main Colliery, and examined a long though narrow fissure in the floor, from which, up to within a few days of their visit, fire-damp had continued to escape since an outburst in 1877. The Midland Institute did good service by publishing, in 1879, a narrative of the most remarkable cases of this kind, which occurred in the workings of the Silkstone and Barnsley seams. Mr. Embleton added to this an interesting account of an outburst, the fourth within fourteen years, at the Thrybergh Hall Colliery, which had the peculiarity that the gas was given off from a fissure intersecting both roof and floor. We deem it a highly satisfactory proof of the efficiency of pit-discipline that in so many instances an imminent danger, arising without the slighest warning, has passed away without loss of life.

A violent outburst occurred on July, 10, 1882, at Orgreave Colliery, Rother Vale, of which the particulars were furnished to the Commission by the manager. An eruption from the floor, violent enough to knock down several of the men, fouled the return aircourses in a few minutes to a distance of 1,250 yards, and yet, three and a half hours afterwards, hardly a trace of gas to be found except in the particular stall of long work where the outburst occurred.

In several of these cases the formation of a definite crack in the floor, generally very near the working face of the coal, and sometimes approximately parallel to it for a few yards, apparently connects the relief of the imprisoned gases in the underlying strata with the form which the workings present at that time. This surmise is confirmed by the frequently observed prelude of a "weight" or the sudden or gradual yielding of the strata above and below, during which the rending of the rock by fissures is seen not unfrequently to follow the heaving of the floor. Such fissures may occasionally occur in narrow or "strait" work as well as in front of the face of bank or long wall. The question as to the possibility of adopting preventive measures is not therefore to be decided by simple reference to the system of working. We, however, consider that whatever be the system adopted, all practicable precautions should be taken with a view to avoid unequal and heavy falls in the goaf, an important one being the introduction, as abundantly as reasonably possible, of pack walling and stowing.

In South Wales the collieries of Risca and Abercarne, opened in the "Black Vein," have met with such disasters of this class as to have led to a special inquiry by three of Your Majesty's Inspectors of Mines. In this noted seam, worked also actively at Celynen, sudden discharges have taken place with unusual frequency, although, from the fortunate absence fatal accident, they have in some instances not been made public. Thus in 1852 one of us happened to be in the bottom of the pit at Abercarne during the operations of sinking to the Black Vein seam, in company with the manager, the late Ebenezer Rogers, and twelve other persons, when the floor of hard shale suddenly heaved and burst, and released a quantity of gas and water which at once extinguished all the lights. On descending an hour later it was found that the gas had all disappeared, having been dispersed by compressed air carried to within a few feet of the bottom by means of a small pipe.

Other similar outbursts have taken place there at intervals. On 1st of May, 1867, and on the 18th of August, 1869, when the colliery was attaining large dimensions, two outbursts, of which full particulars were collected by the late Mr. Inspector Brough, occurred on a scale that might have produced terrible explosions, but for the effectual manner in which they were met. At last came the frightful disaster of September, 1878, causing the deaths of 268 persons. The heavy falls which then occurred on almost every side of the shafts made it impracticable to enter the interior workings, so that a mystery still hangs over this catastrophe, relieved only by the little explanatory light afforded by the evidence before the coroner and by the previous history of the seam.

The cause of these sudden outbursts is involved in great uncertainty; many circumstances probably conspire to produce them, but the high pressure which it is found that gas can attain in plugged bore-holes supplies some clue to the storage of the energy exhibited during an outburst, as correspondingly high pressures may be attained in close cavities which may possibly occur naturally or which are formed during the progress of mining operations.

Probably thin seams of coal, or bands of shale or stone associated with carbonaceous products, lying under or over the workings, play an important part in supplying the gas, while faults in the ground and the nature and mutual adherence of the strata, coupled with the redistribution of pressure consequent on the removal of the coal from the workings, may furnish the means of liberating this gas, and of putting in evidence the energy stored it.

However coal may have been formed, it seems almost impossible to imagine that a seam will maintain in all respects a uniform character. Some portions must be more porous than others, and into these porous regions the gas, as it was formed, either by the decomposition of the original plants or by subsequent changes during geologic ages, will be certain to have found its way and to have become constantly more and more compressed by the increasing cover. Such a porous part of a seam may, therefore, be really a magazine of gas more or less clogged with small coal or carbonaceous matter. When the wall of this magazine, consisting of more compact coal, is thinned sufficiently in the process of working the seam, the pressure of the gas may burst the wall, and the gas will then suddenly invade the workings, carrying with it the small coal with which it has been associated.

The phenomena exhibited by blowers and by eruptions of gas from the roof or floor of a mine indicate that the gas must be contained in spaces more or less free from solid matter, and that in certain cases these spaces must be in communication with somewhat extensive

*From "Final Report of Her Majesty's Commissioners appointed to inquire into Accidents in Mines, etc," 1886.

surfaces yielding gas. It is impossible to suppose that gas can be discharged from the pores of even a very porous body with the velocity observed, or that a cavity can be so large as to contain a quantity of gas which requires years for its emission. Such cavities moreover, have never been found, although they have been carefully sought for, and this circumstances constitutes the principal difficulty in explaining the cause of outbursts. The comparatively small size of the space required to give rise to many of the outbursts which have been recorded may in some measure account for their having been discovered. Thus for instance, if a cavity filled with ordinary fire-damp at a pressure of fifty-one atmospheres be put in communication with the workings, the gas discharged will be sufficient to bring the air of the mine to the most explosive condition throughout a volume 550 times that of the cavity. It is, moreover, very probable that the rending of its walls, and the sudden release from pressure, will cause the cavity to collapse, so as to leave only slight traces of its former existence.

It is not difficult to form an idea as to the manner in which cavities may come into existence and yet escape detection. When a seam of coal or bed of shale or porous stone is charged with gas at a high pressure, this gas will have been retained in the place where it has been formed or collected, by the impervious nature of the adjacent strata and by the weight of the superincumbent ground so long as the natural state of the strata remains undisturbed. The circumstances become, however, altogether changed when the coal is removed from an adjacent seam, as by this process the pressure on the imprisoned gas is or may be relieved in the vertical direction and increased in the horizontal direction. If now the strata between the gas and the working will yield to the pressure of the gas and the lateral thrust due to the weight of the superincumbent ground (and such yielding merely depends upon the existence of an adequate force since all bodies are more or less flexible), then a cavity may be formed, more or less following the plan of the open workings, which may contain gas at a very high pressure.

In this way a part of the whole of the workings of a mine may have, above or below, a kind of low tunnel or space filled with gas ready to burst into the workings, whenever the intervening strata are unable to resist the forces to which they have become exposed.

This tunnel is indeed a cavity, but its existence might easily escape detection in boring through it (except by an abnormal escape of gas) owing to its small height. As an illustration of this effect it may be mentioned that if the cavity have the same horizontal plan as the part of the workings above or below it, and an average height of only fourtenths of an inch, it will contain sufficient gas, at the very moderate pressure of twenty atmospheres, to bring the air in this portion of the mine to a highly explosive state, supposing the height of the workings to be 7 feet.

In long wall workings this tunnel or cavity if formed below the floor, will be more or less parallel to the face, between the unworked coal and the goaf. In the goaf the settling down of the roof upon the floor may reduce the condition of the strata, as regards mutual pressure, approximately to that which existed before the coal was removed. An outburst, if it occur, will therefore, most probably take place place near the long wall face, and the rent in the strata is almost certain to be nearly parallel to the face. If the face is not continuous but in steps, the gas is most likely to find its way into the workings at or near the end of a step. Here the tunnel in which the gas is contained, probably changes its direction, the strata above are bent in all directions, and consequently across the direction of least resistance to flexure.

In pillar workings it would, for the same reason, seem to be most likely that an outburst from the floor, will occur at or near the corner of the pillar and that the rent will extend from this point more or less parallel to the open passages.

It would appear therefore that, in mines subject to sudden outbursts, the long wall system of the working is preferable when other circumstances do not render it impracticable, but it is especially desirable to avoid steps in the face.

If the gas-bearing stratum be near the workings, and the floor or roof of the mine as the case may be, consist of materials having small power of resisting pressure, the gas will break through before it has attained to any great pressure, and the comparatively small quantity thus thrown into the workings will be swept away by the air current, possibly without attracting attention. If, on the other hand, the gas lies at a considerable distance from the workings and the intervening strata are strong, then violent outbursts become possible and a volume of gas may suddenly be poured into the mine, which no practicable ventilating current can for the time dilute sufficiently to prevent an explosive mixture from being formed.

From the "Narrative of sudden outbursts of gas," which has been published in the Transactions of the Midland Institute of Mining Engineers, it appears that the gas has in some cases come from a depth of more than 50 feet below the workings, through several feet of hard rock, which had been shattered and upheaved, at the place where the outburst occurred, in such a way as to indicate that the gas had been confined below it at enormous pressure. In a bore-hole put down through the rock to the layer of shale and coal, from which the gas in these cases seemed to come, a pressure from the gas of nearly nine atmospheres were registered, and it was still increasing when the measurement was made.

Much valuable information in reference to outbursts has been furnished by several of the witnesses examined by us, and it seems to agree with the above suggestion as to the manner in which they are caused.

Mr. Mammatt mentions a cavity "three feet in depth, and 300 yards long like a culvert" which was formed in the floor of a narrow working. This, no doubt, was formed by the swelling of the spavin floor, as the result of being watered, aided by the lateral thurst due to the pressure from the unworked coal, but it very well illustrates the formation of such a tunnel as has been above suggested, running parallel to an open passage in the coal. It does not appear that there was any gas in the cavity described by Mr. Mammet, but if it had been in connection with a stratum yielding gas at considerable pressure, and had been covered by a resisting material, it would soon have become a large magazine of gas.

Mr. Jordan describes the formation of a cavity such as has been suggested, in the roof at Abercarne Colliery and at some of the Ebbw Vale Collieries, about four feet above the coal. This cavity contained gas apparently at considerable pressure, and it seems not unlikely that the disastrous explosion at the former colliery may have been due to an eruption of gas, which broke through the layer of bind and coal between the cavity and the workings. To meet this possible source of danger "a gas drain" was formed at Ebbw Vale, simply by increasing the height of one of the roadways up to the hard stone which formed the roof of the cavities; by this means they were drained, the gas, which gradually escaped before it had attained to any great pressure, being swept away by the ventilating current.

Mr. Embleton describes the forcing down of strong rock roof by the pressure of gas, above it, in some cases the roof came down with an escape of gas, in others the roof recovered its normal position when the gas had found a vent. He also describes outbursts from the floor, and points out the advantage sometimes gained by boring into the roof or floor until the stratum of gas is reached and thus allowing the gas to escape before it has accumulated to a dangerous extent.

Mr. Craig also refers to the forcing down of a strong rock roof by the pressure of gas above it, and mentions a case in which the gas came apparently from a thin seam 72 feet above the workings, through fissures, in the intervening stratum of hard rock.

A contiguous bed of porous shale or stone impregnated with gas, underlying impervious strata, may be a greater source of danger than a seam of coal, as, owing to the greater porosity of the former, the gas will escape more rapidly into any cavity which may come into existence. Moreover the formation of cavities depends very much upon the elasticity of the strata between the gas and the workings, and also upon the adherence of the strata to one another. Easy partings will obviously favor the formation of cavities such as have been above described.

A careful study of the strata overlying and underlying the seam which is being worked may often disclose conditions fraught with danger, which may be rendered harmless by proper precautions; no opportunity should therefore be lost of gaining accurate information as to the physical properties of the materials adjacent to the workings, and of considering the probable effects of disturbing the strata above and below.

Good results have in some cases been obtained by putting in bore-holes in advance of the face, especially in approaching faulty ground, and by boring holes in the roof or floor, so as to facilitate the escape of gas before it has attained to a dangerous pressure in any cavity which may have been formed.

When the gas-bearing stratum is near the workings, a system of bore-holes may be carried out, and this plan is adopted in some mines. But where the gas comes from a stratum at a considerable distance from the workings, as appears to be the case in some parts of the Silkstone seam, an adequate number of bore-holes would require so much time and labor for their execution and would involve so much additional expense, that this method of attempting to lessen the danger ceases to be practicable.

Though something may be done to render them less frequent, it is probable that outbursts cannot be prevented. The only real safeguards against the serious consequences of such accidents is to be always prepared for incursions of gas, by ample ventilation, by working entirely with efficient safety lamps, which will resist the action of strong currents of an explosive mixture of gas and air, by abstaining as much as possible from the use of powder, and by maintaining strict dicipline.

In a communication made to the Secretary of State, Mr. John Moore, of Eastwood, Notts, has pointed out distinctly the danger accruing from gas lodging in cavities produced by the giving way of the roof-stone; and in addressing your Commissioners Mr. W. Morgans, of Bristol, has dwelt with much force on the probability of the communication of flame

through the cracks and fissures formed by the settlement of the strata over the worked portion of the mine.

When a large quantity of fire-damp is suddenly thrown into the air of a mine by one of these outbursts, it is quite possible that, in one portion of the workings, the air may be mixed with so large a quantity of gas that the mixture ceases to be explosive, though it could still burn more or less rapidly. Proceeding from this place in either direction, that is, against the ventilating current or with that current, an explosive mixture would be found, and further still again an inflammable mixture containing a smaller percentage of gas than is required to render it explosive.

If now an explosion should occur, it would of course extend to the whole of the explosive and inflammable regions, but the products of combustion would not be the same throughout. Where the mixture contains more than 9.5 or 10 per cent. or marsh gas, carbonic oxide will be formed as well as carbonic acid, and may escape further combustion. The after-damp in such a case will contain carbonic oxide, and air containing only one per cent. of this gas is eminently poisonous.

The presence of this dangerous gas in after-damp has never been distinctly proved, but its existence is possible in that resulting from an explosion consequent on an outburst and it would be fatal, much more certainly than carbonic acid, to men overtaken by the after-damp.

Special Methods Proposed for the Removal of Fire-Damp.

In former days, in workings of limited extent; and with only small quantities of gas present, it was the custom to fire the inflammable or explosive mixture at varying intervals. Hence the *fireman* of South Staffordshire, and the *pénitent* of French coal fields used, not very long ago, to descend before the men, and with certain precautions to apply a light at the end of a long stick to suspected places. Mr. Dickinson has informed us that this practice of purposely firing the gas was still in vogue in 1851 in the St. Helens district in Lancashire.

It is surprising to find so dangerous a system still occasionally advocated by eminent men, and that proposals for its use should have recently been made to our Government. In Saxony, up to the time of the disastrous accident, December, 1st, 1879, at the Brückenberg mine, at Zwickau, it was recognized by authority as a regular system to suspend open lights termed "eternal lamps." *Zehr Lampen, ewige Lampgen,* in the higher parts of the workings, to burn away the gas; but the inquiry instituted by the Saxon commission has led to a modification of the law, by which, after the 27th May, 1881, this dangerous practice was no longer permitted in workings where the safety lamp is considered desirable.

More recently, the process of Herr Körner of Freiberg attained in 1881 a considerable local reputation as having fulfilled, at certain coal mines, its promised office of consuming the gas. Taking advantage of the catalytic property of spongy platinum and palladium, asbestos coated with thin film of these substances was heated to a dull red over a petroleum lamp, and a combustion at low temperature maintained in any rise working place where the gas might be expected to lodge.

Careful trials made in the Westphalia and Saarbrücken coal field have shown that under the most favorable conditions the effect has been extremely feeble, in others almost null; and the inventor has candidly averred that he never proposed his schlagwetter zehrapparat as a rival to ventilation, but only as an aid in limited working places.

It is, we think, sufficiently obvious that this and other analogous suggestions, such as that of purposely firing the gas electrically at stated intervals of time by means of wires extended through the ramifications of the mine, cannot be susceptible of safe application. On the one hand, their projectors are not aware of the excessive danger that would be incurred, on the other they lose sight of the fact that the burning of the gas must contaminate the air by the products of combustion to a more or less dangerous extent.

Other equally impracticable, and still more visionary suggestions for destroying fire-damp, either by chemical re-actions, or by absorbing it by currents of high-pressure steam have been made.

Atmospheric Conditions.

Much discussion has arisen from time to time, and very conflicting conclusions have been arrived at, with respect to the influence of the variations of atmospheric pressure on the condition of mines in which fire-damp is given off. We have carefully examined a large amount of information on the subject which has been collected and tabulated in this and other countries, and we have given special attention to the observations and experiments at Karwin to which reference has already been made.

Wherever gas is accumulated in old workings there can be no question that its dilatation, consequent upon a reduction of atmospheric pressure, is liable to produce a dangerous state of things. In some cases, where a large range of cavities communicates with a narrow passage, many yards of the latter may thus be fouled by even a small expansion of the gas, and where the goaf is standing partially open the gas contained in it will emerge and possibly cause the air in such a passage to become in a highly dangerous condition before any fall in the barometer has been detected. Thus a goaf of only one acre area with an average height of one yard will put out about 44 cubic feet of its gaseous contents for a diminution of pressure represented by 0.01 of an inch of mercury, which would not be perceptible on an ordinary barometer.

In forming an opinion as to the importance of this question we must draw a broad line of distinction between those collieries in which an active ventilation is constantly maintained by powerful agents, and those in which a natural ventilation is trusted to, or where only a feeble current is artificially conducted through the workings. It needs no argument to show that under these latter circumstances the condition of the air of the mine must be seriously affected by atmospheric changes, and that the barometric, thermometric, and hygrometric phenomena must be taken into account in estimating the present and impending state of the air in the mine workings.

It has been suggested that warnings of approaching changes in atmospheric conditions might be issued by the Meteorological Office to colliery districts in the same manner as they are communicated to the sea parts; and a recent memorial from a body representing a large number of the coal miners, was addressed to the Secretary of State, to propose the establishment of meteorological observatories with this object in view.

We do not think that any benefit would arise from the establishment of additional observatories, and except that, in reference to what has been stated above, it would be advantageous to a manager of a colliery to know that a barometric depression was approaching, we do not understand on what principles, in the present state of our knowledge, warnings worthy of any confidence could be issued. We consider, moreover, that the official dissemination of warnings might lead to an exaggerated estimate of their value, and might consequently be liable to withdraw attention from the absolute necessity for constant watchfulness in taking all precautions essential for guarding against the accumulation of fire-damp in any part of a mine.

The closely allied question of the connection of actual colliery explosions with atmospheric changes has received our careful attention. Some remarkable instances have appeared to support the view that explosions accompany unusual depressions or specially rapid falls in the barometer, but the evidence which has been adduced to show that this view is of general application, seems to us most imperfect and unworthy. Indeed the absence of a general connection between colliery disasters and barometric changes is practically established by the tables compiled by some of Your Majesty's Inspectors of Mines, by the Northern Institute of Engineers, and recently by Mr. Thomas Embleton, in communications made to the Midland Institute.

A dangerous condition in a mine may obviously be produced by a great variety of causes, of which changes in atmospheric pressure form only one, probably the one of which the action is best understood, and which is consequently least to be feared in a properly laid out and well ventilated colliery. Though we would in no way discourage the regular observation of variations in the height of the barometric column, we consider it both unscientific and of little practical value to attempt to correlate explosions with this one cause, and we think such attempts are calculated to draw away attention from other and possibly more potent sources of danger.

Putting aside carelessness and mismanagement, it seems to us that a very large proportian of the accidents of this kind is due to the sudden intrusion into the workings of gas from the strata, generally in such moderate quantity as to be unworthy of the title of an outburst, but nevertheless sufficient, especially in the presence of coal dust, to be capable of originating under certain circumstances an explosion of the worst character.

This gas may sometimes accompany falls of roof or visible movements of the strata, but at other times it may appear without any circumstance to attract attention, and we consider it not impossible that earth shakes or tremors, which only delicate apparatus reveal, may be instrumental in liberating pent-up gas. Such a cause would help to account for the occurrence of a number of explosions at short intervals of time in distant places, and we think that observations of such tremors at a few stations distributed over the country might furnish useful information.

Whether or not, however, the circumstances which determine the appearance of gas in coal mines be more fully ascertained than they are at present, there is only one method of avoiding explosions, and that is to employ means of illumination and methods of breaking down stone and coal which are unable to ignite gas if it should be present.

In one case at least it has been suggested that an explosion has been caused by lightning descending a shaft and igniting an accumulation of gas. Though such an occurrence, needing as it does, the simultaneous existence of several favorable conditions, must necessarily be rare, it cannot be said to be impossible. Considering the elevated position of the pulleys, the metallic winding gear, and the wire-guide ropes connecting the pit-head with the sump which constitute a more or less imperfect conductor, it is remarkable that so little damage is done by lightning in winding shafts. It is certainly desirable that the ele-

vated erections on which the pulleys are fixed should be properly protected by efficient lightning conductors.

(TO BE CONTINUED.)

Municipal Engineering; Paper No. 3.*

WASHINGTON, D. C.

(*Continued from Page 214.*)

Partial Specifications for Sewer Work, Washington, D. C.

The material from the trenches and that used in the construction of the work shall be so deposited as not to endanger the work or unnecessarily obstruct public travel, and so that free access may be had at all times to all fire plugs and water gates in the vicinity of the work. The surplus earth as hereinafter indicated will be the property of the contractor and must be disposed of by him.

SEWER.

The sections of the various sewers are to be made in strict conformity with the drawings furnished by the Engineer Commissioner, and the lines and levels given by the duly authorized assistant, and the directions given from time to time by the Engineer Commissioner or his agents. The work is subject to such modifications as may be necessary during its progress; and in no case will any work in excess of the plans and specifications be paid for unless ordered in writing by the Engineer Commissioner. Water-tight work is required, and, to secure this, none but the best quality of material of the several description shall be used. All work shall be done by skilled workmen in the various departments of the same. Proper moulds, centres, and forms will be furnished and kept in good condition by the contractor.

All railroads, water, sewer, and gas pipes across or near the work shall be supported during the construction of the work under or near them, so as not to interfere with or delay the use of said railroads or the flow of water, gas, or sewerage; all at the expense of the contractor.

The existing sewers in Boundary and other streets shown on the drawings in the office of the Engineer Commissioner must be protected and secured against damage by and at the expense of the contractor.

The connections of intercepted sewers and catch-basin connections with the new sewers will be made according to the plans and directions given by the Engineer Commissioner and the cost of said connections included in the price per foot for new sewers. The connections with new basins will be paid for at a separate price. The connections with sewers will generally be made with curves having a radius of not less than thirty feet. Drops for the dry weather flow are to be built in the Boundary and O street sewers, not exceeding three. These will conform to the drawings on file in the office of the Engineer Commissioner and the cost of the same will be included in the price paid for those sewers.

BRICK-WORK.

The best quality of whole new bricks, burned hard entirely through, free from injurious cracks, with true even faces, and with a crushing strength of not less than 5,000 pounds per square inch, will be used, and must be thoroughly wet by immersion immediately before laying. Every brick is required to be laid in full mortar joints, on bottom sides and ends, which for each brick is to be performed by one operation. In no case is the joint to be made by working in mortar after the brick has been laid. Every second course will be laid with a line, and joints will not exceed ¾ of an inch. The brick-work of the arches shall be properly bonded and keyed as directed by the Engineer Commissioner. No portion of the brick-work will be laid dry and afterwards grouted.

Terra-cotta junction blocks will be built into the arch of the brick sewers, and Y branches laid in the pipe sewer at such places as are shown on the plan, or are indicated by the Engineer Commissioner. These will be furnished the contractor free of cost, and are to be built into the sewers, and the ends projecting from the concrete foundation closed with brick and cement by and at the expense of the contractor.

MANHOLES.

Brick manholes will be constructed in the sewers at intervals of 150 to 300 feet. They are to be of form and dimensions shown on the drawings. Manholes in sewers over 5 feet in vertical height will spring from one side of the arch of the sewer; in smaller sewers, from the top of the arch.

RECEIVING BASINS.

Receiving basins will be built wherever shown on the plans, or ordered by the Engineer Commissioner. They will conform to the drawings, will be built with care, and be made perfectly water-tight by plastering the interior with neat hydraulic cement ½ inch in thickness.

The tops of the basins will be covered with granite or blue stone heads set level with the sidewalk; the stones composing the tops will be rebated to receive a cast-iron cover similar to those now in use in Washington.

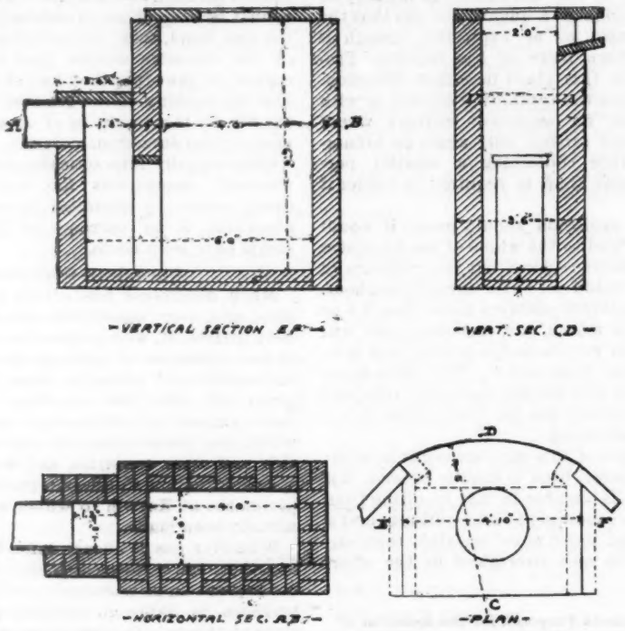

Plate 22.—Sewer Inlets.

Connections of basins with the sewers will be made with 12-or 15-inch pipes of tetrra-cotta, laid in cement concrete, as required for the sewer-pipes.

MORTAR.

Mortar, wherever used in this work, will be composed of cement and dry sand, in the proportion of 300 pounds of cement and two (2) barrels of loose sand, *thoroughly mixed* dry, and a sufficient quantity of water afterwards added to form a rather stiff paste; it will be used within an hour after mixing, and not all if once set.

Cement shall be of the best quality, freshly-burned and equal in every respect to the Round Top or Sheppardstown cement, manufactured upon the formula of this office, capable of being worked for twenty minutes in mortar without loss of strength, and will be tested in such manner as the Engineer Commissioner may direct. It will have a tensile strength, as follows: when mixed with water and allowed to set for twenty-four hours, then immersed in water until taken out in testing at the expiration of one week thereafter.

Neat cement	95	lbs. per sq. in.
One part cement and one part sand	56	"
" " two "	22	"
" " three "	12	"

Sand used should be clean, sharp, free from loam, vegetable matter, or other dirt, and capable of giving the above results with the cement.

Water used shall be fresh and clean, free from earth, dirt or sewerage.

Tight mortar boxes shall be provided by the contractor, and no mortar shall be made, excepting in such boxes.

The proportions given are intended to form a mortar in which every particle of sand shall be enveloped by the cement, and this result must be attained to the satisfaction of the Engineer Commissioner and under his direction.

The thorough mixing and incorporation of all materials will be insisted upon, preferably by machine labor, but if done by hand labor the dry cement and sand will be turned over and mixed with shovels by skilled workmen not not less than six times before the water is added. After adding the water, the paste will again be turned over and mixed with shovels by skilled work men not less than three times before it is used.

CONCRETE.

Concrete will be composed of mortar proportioned and mixed as before described, to which will be added broken stone in such proportion that the resultant mass will contain for every 300 pounds of cement two barrels of loose dry sand, and five barrels of broken stone or hard brick.

The stone or brick will be added immediately after

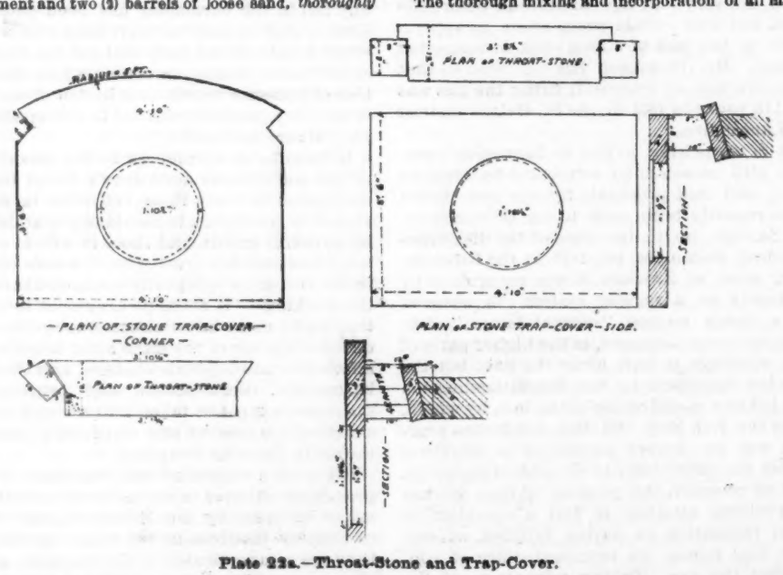

Plate 22a.—Throat-Stone and Trap-Cover.

*Copyrighted by ENGINEERING NEWS PUBLISHING Co. 1894.

mixing the mortar, being first completely drenched with water, but containing no loose water in the heap.

The whole mass shall be thoroughly turned over and mixed until every particle of broken stone is completely covered with mortar, using only sufficient water to insure the proper incorporation of the ingredients.

The proportions given are intended to form a concrete in which the cement mortar shall be sufficient to fill all the void spaces with mortar in excess. If from imperfect mixing or other cause it shall appear to the Engineer Commissioner that such a result is not attained, the proportion of broken stone or brick will be adjusted

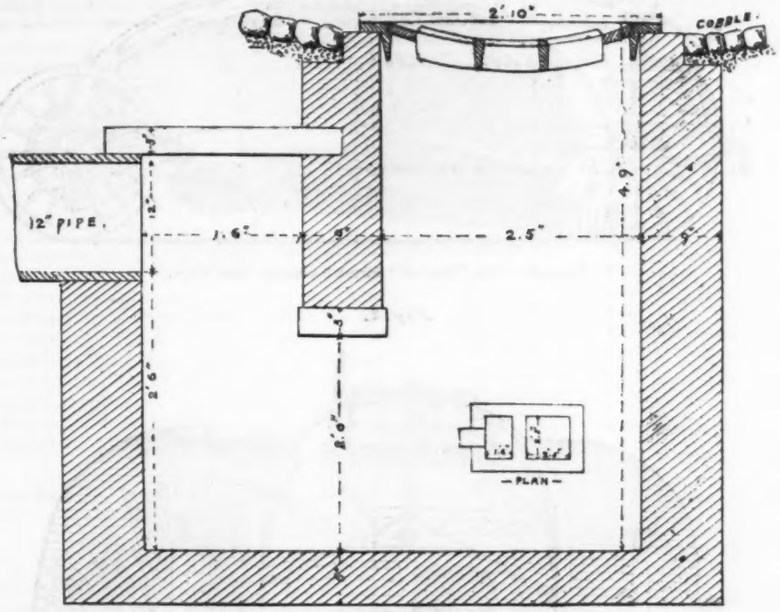

Plate 23.—Alley and Gutter Drop.

If not mixed by machinery, the concrete material will be turned over and mixed with shovels by skilled workmen upon a water-tight platform of sufficient size not less than four times before it is used.

Broken stone or brick shall consist of angular fragments of sound durable stone or brick, broken preferably by the crusher or roller, not exceeding 1½ inches

to his satisfaction without extra compensation. If it should be found that the stone is so proportioned that the mortar is considerably in excess of the amount required to fill the void spaces, the proportion of stone will be increased, but only upon the written order of the Engineer Commissioner.

Each batch of concrete will be rapidly mixed and

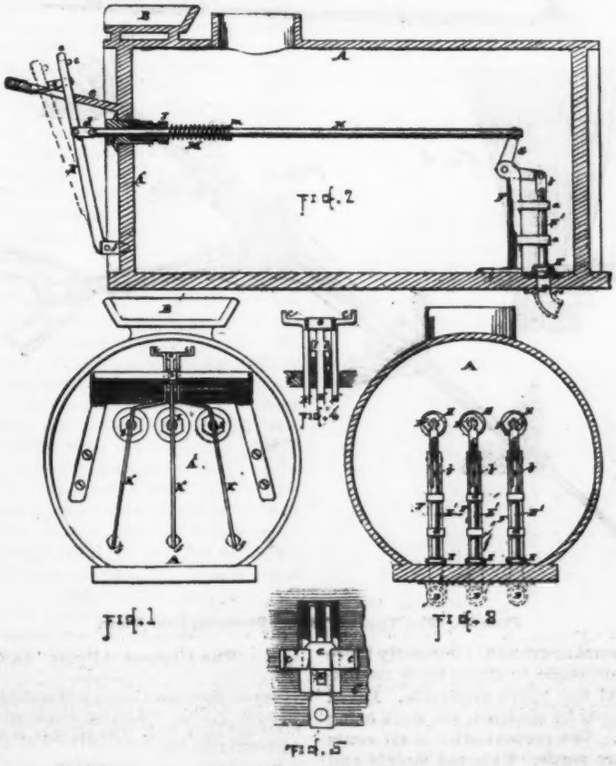

Plate 24.—Monitor Sprinkler.

in their greatest dimension, and will be thoroughly freed from dust and dirt by screening or winnowing. After the latter operation it will not be deposited or handled except upon clean boards.

spread in layers not exceeding 6 inches in thickness, and will be at once thoroughly compacted by ramming until free mortar appears on the surface.

The concrete will not be allowed to be passed down to its place in a shute, but must be deposited so as to retain the mortar evenly incorporated with the stone and free from foreign matter of any kind.

The whole operation of mixing and laying each batch will be performed as expeditiously as possible, with the use of machinery or of a sufficient number of skilled men.

The concrete will be accurately laid to the prescribed section by the use of proper templates or forms; and in case any of the sewer arches are built of concrete instead of brick, the contractor will be required to prepare the centres so that the concrete will not adhere to them, and so that when removed the intrados of the arch will present a perfectly smooth finished surface. If necessary, the intrados will be plastered with cement mortar.

Concrete will be allowed to set at least twenty-four hours before any work or back filling shall be p it upon it, and no walking over or working thereon will be allowed during such time.

SEWER PIPE.

Sewer pipe will be circular, vitrified stoneware, or terra-cotta sewer pipe, of the dimensions specified, and laid in a bed of hydraulic cement concrete, as shown in the sections on file in the office of the Engineer Commissioner.

For sewers with half pipe inverts the pipe will be carefully divided longitudinally in halves, and laid in place by being imbedded in mortar composed of one (1) part best quality fresh Portland cement, and one and a ha'f (1½) part clean sharp sand, mixed and used as required for cement mortar. The bed for the pipe will be formed one-half (½) inch in thickness entirely around the pipe, the joints fully flushed, and the cut edge of the pipe covered by the mortar, with the mortar flushed up to the brick-work, as shown in the drawings. The Portland cement must have a tensile strength of 250 pounds per square inch when mixed with water only, and five days after setting.

STONE BLOCKS FOR INVERTS.

The invert of sewers larger than 4 feet x 6 feet will be laid with stone blocks, as shown in the sections. The blocks will be laid with full joints in Portland cement mortar of the quality and mixed in the manner above specified.

MISCELLANEOUS.

The junction of different diameters of new sewers will be made with conical sections sixteen (16) feet or more in length, retaining the slope of the arch of the sewers.

The ends of all sewers, except at their discharge, will be securely closed with brick masonry laid in cement mortar, as prescribed for brick-work.

On the completion of the sewers, they shall be thoroughly cleaned out before acceptance.

The drainings of sewer inlets referred to in the above specifications are shown in plate 22. These are built either at street corners or as side traps. The opening for the admission of water is 8 inches in height and 3 feet 1¾ inches, and 3 feet 5½ inches in width respectively in the corner and side traps. The interior of the receiving basins is 2 feet by 4 feet, and 6 feet in depth. The stench-box is 1 foot 3 inches square, and the bottom of the discharge pipe is 6 inches above the top of the opening from the receiving-basin into the stench-box. The cover of the basins is of blue stone 4 inches in thickness, and has a manhole 2 feet in diameter, closed with a cast-iron cover. The throat-stone and side-stones are of granite. Other parts will be thoroughly understood from the specifications and drawings. The alley and gutter drop shown in Plate 23 is of the same general construction only smaller, and is covered with an iron grating. These are used in alleys, in the gutters of streets, and at pumps and public hydrants to carry off waste water.

Catch-basins are cleaned periodically by a force of men under the Superintendent of Streets. The accumulated filth is removed by scraping it into a wooden bucket, with a long handled hoe, and hoisting it out through the manhole to be carted away. The basin is then flushed with a hose, bringing water from the nearest fire hydrant.

Street Cleaning.

The paved streets are cleaned by contract at a stated price per 1,000 square yards for each time swept, cleaned, and the sweepings removed. The streets are swept at stated in-

tervals varying from daily for some streets to once in two weeks for others, according to a schedule prepared by the Commissioners. Most of the residence streets are swept once a week. The present price for sweeping, cleaning and disposal of sweepings is 28½ cents per 1,000 square yards.

The present contractors are L. P. Wright & Son, of this city. On this work they use the "Monitor Sprinkler," Plate 24, patented by L. Bencroft, of Worcester, Mass., in 1872, and manufactured by Abbott Downing Co., Concord, N. H. This is what is known as a three-way sprinkler; that is, the sprinkling pipe in the rear of the tank is divided into three nearly equal parts, each controlled by a separate valve which is worked by a lever operated by the feet of the driver. By this arrangement they are able to sprinkle close alongside of a sidewalk without interfering with persons walking alongside. The "Capital Street-Sweeper," of which two views are shown, is their own invention and is manufactured by them. Plate 25, Fig. 1 is a side view, and Fig. 2, a rear view; Fig. 3, the broom-shaft and gearing, and Fig. 4, one of the small brooms that are attached to the broom-shaft. The broom makes an angle of 45° with the axis of the machine; is 12 feet long and sweeps 9 feet in width. When new it is 5 feet in diameter and with the broom-shaft weighs 650 pounds. It is used until it is worn down to a diameter of 2 feet, when it is renewed. This broom is made up of ninety-six small brooms, made from white birch twigs, any one of which can be removed at any time. The whole broom-shaft is hung from the center, which allows it to readily accommodate itself to any uneven surfaces as the crosses of the streets. The machine is made entirely of iron, except the wheels, and is heavy enough so that it removes any kind of dirt from depressions in the pavement, railroad tracks, etc. It is drawn by four horses and sweeps from the center of the street to the right into the gutters.

In cleaning a street the sprinkler proceeds the sweepers, wetting the surface just enough to lay the dirt, taking water from fire-hydrants along the route of the work. The sweepers follow immediately behind the sprinkler, and sweep all the dirt into the gutter, these are followed by men with wide hoes and stable-brooms, who hoe and broom it into heaps; these are followed by men with scoop shovels, who load it into carts to be hauled away. All the work has to be done between the hours of 10 P.M. and 10 A.M. except in the winter months, when the work is done in the day-time if the temperature is below the freezing point at night. One machine sweeps 125,000 square yards in a night of ten hours. Messrs. Wright & Sons manufacture and use a machine, the patent of which they own, for scraping mud off the street in the spring when too heavy and deep for the sweepers. It consists (Plate 26) of an iron frame, underneath which, extending diagonally across, are twelve steel shovels, which are pressed down against the pavement by heavy steel springs, thus allowing a vertical movement of the shovels to accommodate any unevenness of the street. This machine is drawn by four or six horses, according to the work, and will do the work of 200 men with hoes. It scrapes the dirt to the right in the same manner as the sweepers. By reversing the machine it is used for scraping the snow from the gutters toward the center of the street, to allow the water to run off in time of a thaw. In sprinkling the streets the amount of water used varies according to the state of the atmosphere, just sufficient being used to lay the dust. The sweepings are hauled to the nearest dumping ground. Formerly there was an attempt made to utilize them for manure, but it did not prove profitable. Paved alleys are cleaned by contract, the work being done by hand. The present price is 42½ cents per 1,000 square yards. Unpaved streets and alleys are cleaned, under the supervision of the Superintendent of streets, by days' labor.

There is no provision made for street sprinkling by the city.

TO BE CONTINUED.

Fig. 1.

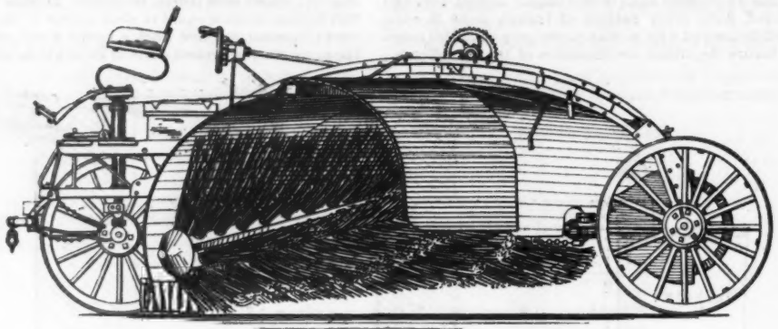

Plate 25.—The "Capitol" Street Sweeper. Side View.

Fig. 2.

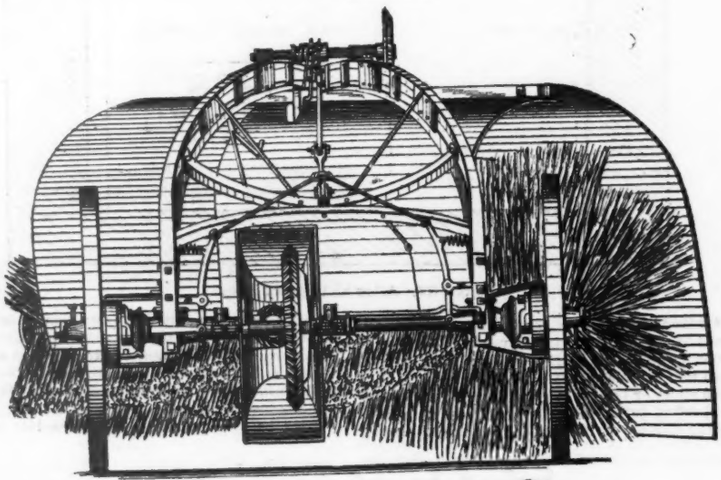

Fig. 4.

Fig. 3.

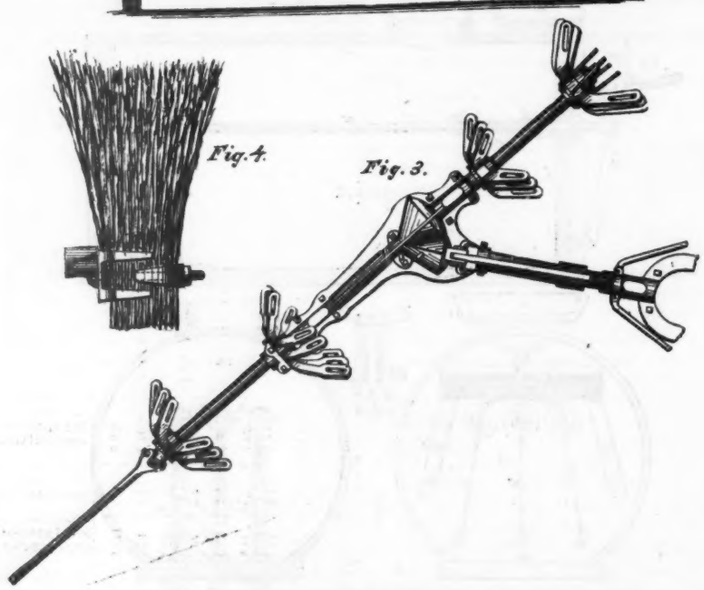

Plate 25.—The "Capitol" Street Sweeper; Rear View.

The Highest "Point" in Ohio.

Senator Sherman's house at Mansfield is at the highest point in Ohio, and in the divide between the Ohio River and Lake Erie. The altitude is 1,300 feet above the level of the sea.

The above paragraph is floating through the press. We copied it and said it was probably a mistake. We copy from the Geological Survey of Ohio (Geology pp. 482) published 1878.

The boundary lines of Logan county are all nearly level, and hold an elevation of between 1,000 and 1,300 feet

above tide water, falling where Miami goes out on the the west to about 975 feet, but the center has been upheaved until the summit, on John W. Hogue's farm, one and one-half miles east of Bellefontaine, has reached the height of *one thousand flee hundred and forty, feet* which equals 1,107 feet above low water at Cincinnati, and 975 feet above Lake Erie, and is *the highest point yet measured in Ohio.*

This disposes of the "highest point." The same authority says that "Richmond county (where Senator Sherman lives) is situated on the highest point of *the divide* between the waters of "Lake Erie and the Ohio river." Again says Geology: "About seven miles west of Mansfield, and near the western line of the county, is an isolated knob, which is designated by residents in the vicinity as the highest land in the county and in the State. It is, however, by the barometer, only 249 feet above Mansfield, or 832 feet above the lake, while two-and-a-half miles farther east the surface rises by a more gentle inclination 30 feet "*higher.*" Hence it is manifest that Hogue's farm in Logan county is the *highest* point yet measured in Ohio. This seems to settle the question that Senator Sherman does not live on the highest point in Ohio, if he is her tallest statesman.—*Exchange Paper.*

On the Cost of Raising Small Quantities of Water by Steam Pumps.

BY ALFRED R. WOLFF, M. E.

Data as to the performance of the larger pumping engines, though always of interest and import, are quite prolific as compared to those relating to smaller steam-pumps, pumps whose hourly capacity is 2,500.000 foot pounds and below. On the other hand, the number of smaller steam pumps in use is so great, and their use so wide-spread, that information as to their economy would appear to be welcome.

The fuel consumption per unit of horse power is, of course, far greater than the figures which we are accustomed to hear quoted in the larger pumping engine practice, and instead of ranging as in the latter between two and four pounds of coal, varies more nearly on an average, from twelve to fifteen pounds of coal per hour per actual useful horse power of pumping effect.

The coal consumption is the most appreciable item of the current expense, except where special attendance must be charged for. Whether such charge is to be made depends upon the situation.

When a steam pump is used in a location where a fireman or engineer has to be employed on the premises to attend to boiler capacity of some proportion, supplying a comparatively large quantity of steam for heating and power purposes, there is no extra charge for attendance on the steam pump. But there are cases where an independent boiler and special attendance are required for pumps whose hourly capacity does not exceed 2,500,000 foot-pounds. In such a case, the hourly expense of raising the water would of course be very great. For it will be remembered that it is the sum of all the current outlays—the sum of the cost of fuel, oil, interest and depreciation of plant, wages and the like which forms the current expense of a prime mover and determines its economy.

The following table shows the performance of steam pumps of moderate proportions, on this basis, and represents average good practice. With what has preceded, it explain itsslef. It is only necessary to say that the interest, as well as the repairs and depreciation, are charged to eight hours of actual work per day, by dividing these costs per annum by $365 \times 8 = 2{,}920$; and that to find the first cost, in dollars, of steam pump without boiler, the figures in column five should be multiplied by $\frac{365 \times 8}{100 \times .05} = 584$. To find the first cost, in dollars, of steam pump and independent boiler, the figures in column seven should be multiplied by 584.

	I	II	III	IV	V	VI	VII	VIII
Gallons of Water Raised 25 feet per hour.	370	1151	2036	2708	3876	5661	7497	12743
Equivalent Actual Useful Horse Power Developed.	0.04	0.12	0.21	0.28	0.41	0.61	0.79	1.34
Pounds of Coal Consumed per Horse Power of Useful Pumping Effect per hour.	15	14	14	14	13	13	13	12
For Interest, 5 per cent of First Cost; Pump without Boiler.	0.17	0.30	0.39	0.43	0.51	0.60	0.64	0.77
For Repairs and Depreciation 5 per cent. of First Cost: Pump without Boiler.	0.17	0.30	0.39	0.43	0.51	0.60	0.64	0.77
For Interest, 5 per cent. of First Cost; Pump and Independent Boiler.	0.41	0.60	0.68	0.81	0.90	1.07	1.15	1.21
For Repairs and Depreciation, 5 per cent. of First Cost; Pump and Independent Boiler.	0.41	0.60	0.68	0.81	0.90	1.07	1.15	1.24
For Coal, $5 per Ton of 2,000 Pounds.	0.15	0.42	0.73	0.98	1.33	1.98	2.57	4.02
For Oil.	0.05	0.07	0.09	0.11	0.14	0.18	0.21	0.25
For Interest, Repairs, Depreciation, Coal and Oil, but no Attendance; Pump without Boiler.	0.44	1.09	1.68	1.95	2.49	3.30	4.06	5.81
For Interest, Repairs, Depreciation, Coal and Oil, but no Attendance; Pump and Independent Boiler.	1.02	1.69	2.18	2.71	3.27	4.30	5.08	6.75
For Interest, Repairs, Depreciation, Coal and Oil, and attendance of one man at 18.75 cents per hour. Pump and Independent Boiler.	19.77	20.44	20.93	21.46	22.02	23.05	23.83	25.50
For Interest, Repairs, Depreciation, Coal and Oil, and one-half time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	10.39	11.06	11.53	12.08	12.64	13.67	14.45	16.12
For Interest, Repairs, Depreciation, Coal and Oil, and one-third time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	7.37	7.94	8.43	8.96	9.52	10.55	11.33	13.00
For Interest, Repairs, Depreciation, Coal and Oil, and one-quarter time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	5.71	6.38	6.87	7.40	7.96	8.99	9.77	11.44
For Interest, Repairs, Depreciation, Coal and Oil, and one-fifth time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	4.77	5.44	5.93	6.46	7.02	8.05	8.83	10.50
For Interest, Repairs, Depreciation, Coal and Oil, and one-sixth time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	4.15	4.82	5.31	5.84	6.40	7.43	8.21	9.88
For Interest, Repairs, Depreciation, Coal and Oil, and one-seventh time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	3.67	4.31	4.83	5.36	5.92	6.95	7.73	9.40
For Interest, Repairs, Depreciation, Coal and Oil, and one-eighth time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	3.36	4.03	4.53	5.05	5.61	6.64	7.42	9.09
For Interest, Repairs, Depreciation, Coal and Oil, and one-ninth time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	3.10	3.77	4.26	4.78	5.35	6.38	7.16	8.83
For Interest, Repairs, Depreciation, Coal and Oil, and one-tenth time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	2.90	3.57	4.05	4.58	5.15	6.18	6.96	8.63
For Interest, Repairs, Depreciation, Coal and Oil, but no Attendance; Pump without Boiler.	11.0	9.1	7.6	7.0	6.1	5.5	5.1	4.3
For Interest, Repairs, Depreciation, Coal and Oil, but no Attendance, Pump and Independent Boiler.	25.5	14.1	10.4	9.7	8.0	7.0	6.4	5.0
For Interest, Repairs, Depreciation, Coal and Oil, and attendance of one man at 18.75 cents per hour; Pump and Independent Boiler.	491.3	170.3	99.7	76.6	53.7	37.8	30.2	19.0
For Interest, Repairs, Depreciation, Coal and Oil, and one-half time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	259.8	92.3	55.6	43.1	30.5	22.4	18.3	13.0
For Interest, Repairs, Depreciation, Coal and Oil, and one-third time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	181.8	65.3	40.1	32.0	23.3	17.3	14.3	9.7
For Interest, Repairs, Depreciation, Coal and Oil, and one-quarter time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	142.8	53.2	33.7	26.4	19.4	14.7	12.4	8.5
For Int., Repairs, Depreciation, Coal & Oil, and ⅕ time of Att't. at 18.75 cts. per hour; Pump & Independent Boiler.	119.3	45.3	29.2	23.1	17.1	13.2	11.2	7.8
For Interest, Repairs, Depreciation, Coal and Oil, and one-sixth time of Attendant at 18.75 cents per hour; Pump and Independent Boiler.	103.8	40.2	25.3	20.0	15.6	12.2	10.4	7.4
For Int., Repairs, Depreciation, Coal & Oil, and ⅐ time of Att't. at 18.75 cts. per hour; Pump & Independent Boiler.	91.8	36.2	23.0	18.1	14.4	11.4	9.8	7.0
For Int., Repairs, Depreciation, Coal & Oil, and ⅛ time of Att't. at 18.75 cts. per hour; Pump & Independent Boiler.	84.0	33.6	21.5	18.0	13.7	10.9	9.4	6.8
For Int., Repairs, Depreciation, Coal & Oil, and ⅛ time of Att't. at 18.75 cts. per hour; Pump & Independent Boiler.	77.5	31.4	20.3	17.2	13.0	10.4	9.1	6.6
For Int., Repairs, Depreciation, Coal & Oil, and ⅒ time of Att't. at 18.75 cts. per hour; Pump & Independent Boiler.	72.50	29.75	19.33	16.36	12.50	10.13	8.81	6.44

Expense of Actual Useful Power Developed in Cents per Hour.

Expense per Horse Power in Cents per Hour.

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AND

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Subscribers who wish to have complete files of this year's numbers of ENGINEERING NEWS *must make application at once for missing numbers or to replace mutilated copies. We will give one month's subscription for each copy of Nos.* 13 *and* 14 *of this year, uninjured, mailed to us during October. In wrapping cover the whole length of the paper, otherwise they arrive with torn leaves and we will not accept them.*

OUR Paris contemporary *Le Génie Civil* comes to us this week with a conspicuous announcement to its subscribers, to the effect that hereafter all demands for a change of address must be accompanied by the pasted "address slip" from the last copy sent, and "the sum of twelve cents to defray the expense of rectifying the address."

We trust the subscribers to *Le Génie Civil* are not as erratic in their movements as some of our own; if they are, the "sixty centimes a change" will prove quite a tax in the course of a year. At all events, in strict accordance with the Continental system of item-charging, our French brother proposes to be paid for his trouble in keeping track of his clients.

NEWS comes that one of the new eight-inch guns, "made of the best English steel" at Washington has burst at Annapolis, and even the daily papers are beginning to question the system that has produced so many failures.

We have, from time to time, urged the necessity for trials of steel, or even cast-iron guns, of shapes fitted for slow burning powder, cast on the Rodman plan, citing the guns cast by Johnson, of Spuyten Duyvil, the iron in which tested by C. C. Martin, averaged a tensile strength of 42,000 pounds per square inch, while according to Mr. A. H. Emery's statement before the Senate Committee on Ordnance and War Ships, the Firth steel furnished for our first built up guns *ran down* from 60,000 pounds per square inch.

The cast guns can be made with such a small expenditure of both time and money that there seems no excuse for not trying them, particularly as our cast-iron guns have had such a splendid record.

THE Trans-Caspian Railroad is now completed to the Amou-darja and a steamboat on that river opens a freight and passenger route to Kiva. The freight from Nishni-Novgorod to Kiva is according to *Herapath's* 1½ cents per pound. The station on the Amou-darja Chardchui is about 60 miles from Kiva. This route opens to Russian commerce and civilization Persia, Kiva, Bokhara, and Turkestan without injuring their opportunities for trade with Afghanistan.

THE proposed Congo Railway, the organization of which, on paper, was recorded in our issue of January 16th, has been abandoned by its proprietors and "the project which promises to bring civilization to the darkest stronghold of barbarism" will probably be allowed to slumber till the country has been more thoroughly developed. When the project is carried through to success we predict it will be done by American contractors.

THE Government of Ceylon is just now discussing the gauge question in the proposed extension of its railway system. Ever since the introduction of railroads into this part of the world, the standard gauge has been 5 feet 6 inches, this width being adopted in the hope that they would some day connect with the railways of the mainland over an existing series of reefs known as "Adam's Bridge."

But as the Colonial office is now reluctant to increase present indebtedness by extending further this broad gauge, an alternative has been proposed of going to the other extreme, and building on a 2-foot gauge. According to *The Engineer*, careful estimation has shown that the difference between the cost of a 5 foot 6 inch gauge, and one of 3 feet 6 inches in the hill country of Ceylon, is only about £1,000 per mile; while by using a 2 foot gauge the saving over the broad would "approximate £10,000 per mile."

If the above figures are correct, railway building in Ceylon must be a very expensive luxury, when the "saving" per mile over the broad gauge would build a very good 4 foot 8½-inches gauge road complete in even difficult country in this part of the world. They want a few Yankee engineers and contractors in Ceylon.

The Philadelphia Public Buildings.

The last report of the Commissioners for the erection of the Public Buildings of Philadelphia deals with heavy figures in reporting on the expenditures to date and the quantities of work represented by these figures.

The total amount expended to the end of the year 1885 is $11,060,940.07. Of this aggregate the contract of Wm. Struthers & Sons, for marble and marble work, amounted to $5,300,000; for which bills have been rendered for $5,002,729.15, leaving $97,270.85 as the value of the work required to complete this contract.

The report gives the following as the principal quantities of various materials used in construction from the commencement of the work, in 1870, to December 31, 1885:—

Concrete foundations	80,325 cu. ft.
Stone "	899,532 "
Granite (Cape Ann, Blue Hill,)	225,581 "
Marble, (Lee, Mass.)	700,779 "
Sandstone (Ohio)	116,231 "
Polished Granite (N. B. and Mass.)	41,536 "
" Marble (Ver. and Pa.)	12,500 "
Hard Brick (Phila.)	67,995,500
Pressed " "	236,020
White " "	161,750
Enamelled Brick (Phila.)	176,288
Rolled Iron:—floors and roof	3,754 tons.
Wrought-Iron:—clamp, ties, etc.	139 "
Cast-iron:—doors, windows, etc	2,339 "
Copper	22 "
Bond slate	26,298 sq. ft.
Roofing " (794 tons)	96,700 "
Excavation cellars and foundations	145,879 c. yd.

In the year 1885, the Commissioners expended $812,850.17; and they expect with the appropriation for 1886, to complete the masonry part of the principal tower; the interior is being fitted up rapidly. The points now occupying their attention, are the water supply, and the protection of the building against lightning. We have already given the detail of the scheme for water-supply as proposed by Howard Murphy, C. E., the engineer-in-charge. For lightning protection, Prof. Geo. F. Barker, of the University of Pennsylvania, has made a report, and proposes the following plan:—

To protect the tower, during erection, he recommends a complete and continuous metallic conductor properly terminated at the ends, and extending from base to summit of tower. He would employ at least two conductors of copper-wire rope, not less than one-half inch diameter, and made of rather large wires; this rope to be connected metallically at frequent intervals to the iron framework in the main building. At the bottom he would terminate the conductors in the deep well now existing in the center of the tower foundations; and at the summit the conductors would be firmly connected with the iron circular track now there for the travelling derrick, and from this carry suitable lengths of the same wire rope to the most prominent parts of the derrick, and terminate these ropes two or more feet above the highest points of attachment, with the ends of the rope untwisted, so as to present a brush of separate metallic wires.

The principal dimensions of the Public Buildings are as follows:—

From North to South	486 ft. 6 in.
From East to West	470 "
Area covered	4¼ acres.
Height of main tower above pavement	537 ft. 4½in.
Width of Tower at base	90 ft.
Center of clock-face above pavement	361 "
Diameter of clock-face	20 "
Number of rooms in building	520
Total floor area	14¼ acres.

"Liberty" and the Meter.

The torch of Bartholdi's Statue of Liberty is 100 meters above high tide in New York Harbor, so that one way in which Liberty Enlightens the World is by holding the metric measure before our eyes.

The Repaving of Fifth Avenue, New York.

The fact that municipal engineers and other city officials refer to ENGINEERING NEWS for information about municipal engineering and allied subjects, justifies us in again referring to Colonel Balch's careful and voluminous report on the above subject as printed in the *City Record* of September 28th, particularly as it is evidently intended to serve as an authoritative statement of the principles that should govern the laying of stone block pavements.

The repavement of a portion of Fifth Avenue which is *the* residence street of New

York, and is over six miles long, was provided for by a special bill passed by the State Legislature. The items of interest in this bill are: "The said pavement to be of granite blocks, and in order to secure the best description of such pavement, of the best material and workmanship, to be laid in the most substantial manner and with the best foundation, the said Commissioner of Public Works shall, by public advertisement in the *City Record*, invite plans and proposals with specifications annexed for such work," and "the amount necessary to complete the whole work, including the expense of not more than two inspectors and one engineer shall, etc." This wonderful piece of special legislation provided that the contractor should make the specifications, and added to this provision a further one that there should not be more than two inspectors and one engineer. And the board intrusted with the execution of this Act, consisting of Mayor Grace, Comptroller Loew and Commissioner Squire, ably carried out its intent by deciding that the engineer should have $10 per day,—not too large a reward for mediocre talent, yet a sum altogether insufficient to encourage an engineer to employ assistants out of his pay. The insufficiency of the inspecting force is fully shown by Colonel Balch, and should have been foreseen by the city's sworn guardians.

As the result of this competition between contractors, the specifications and bid of Mathew Baird were accepted, as his bid was the lowest; though it cannot be claimed that any one expected him to do good work, and at the best the acceptance of the lowest bid under the circumstances was a piece of thorough cowardice on the part of his Honor the Mayor and his associates, showing a greater desire for freedom from the clamors of the press than for the interests of the city. Whether any of these gentlemen should have known that blocks not less that 4 inches, nor more than 4½ inches wide, were too wide to make the "best description of such pavement" and totally unfit for a street bordered by residences is an open question; Colonel Balch's severe sentence "that incapacity in high officials, even if unaccompanied by venality, is vastly more expensive in the long run than the most thorough and exacting administrative methods guided by capacity and scientific knowledge, and that no government is so ruinously expensive and extravagant as that administered by half educated ignorance," seems applicable, though, if he had substituted self sufficient ignorance he would have characterized the case more aptly; the sentence is a good one however as it stands, and applies to the management of more towns than New York.

The report of Colonel Balch, while it contains evidences of considerable research, is unfortunately written more in the spirit of an advocate than in that of an engineer who desires to make a fair and sufficient statement of the case and its environments. This is unnecessary, however, as beginning with the appointment of the "not more than two inspectors and one engineer" as far as recorded, the whole proceeding has been one of marked inefficiency, and a fraud on the city.

In our last issue we noted the specifications for gravel and sand. It might be objected that the mustard seed definition is not elastic enough. Paving sand surely should be coarser than building sand, and building than plastering sand, while for hard finish a still finer sand should be employed. In the report a screen with a No. 8 mesh is adopted. We think for paving, sand passing a ¼ inch screen might be admitted and that any large percentages of fine sand,—sand which will pass a No. 30 screen—would be more objectionable than that passing a No. 4 screen. The size of the gravel was specified as between ¾ and ¼ inch, so that nothing could justify the presence of larger stones than these in the bedding sand, due to a lack of screening. The description of the proper method of laying stone blocks should be studied by every one who has charge of such work, though the use of the term "compressibility of sand" is unfortunate, most authorities setting forth that sand is an extremely incompressible substance, though it is mobile under many circumstances, ramming by a vigorous paver being one of the most familliar.

Nor is too much emphasis laid on the necessity for freedom from sand in the gravel used in the joints. Engineers often specify that a certain amount of pitch shall be used and watch that it goes into the cracks instead of being spread over the surface of the pavement, thus insuring that the joints are properly filled.

While uniformity in the size of contiguous blocks is necessary if a pavement is to wear, without small depressions occurring, yet it may be doubted if the accuracy secured, only by gauging the three dimensions of each block will pay, if any dependence at all can be placed on the judgment of either engineer or inspector. The operation of inspecting the stones now unlaid on the Avenue is conducted as follows: The force consists of three inspectors, each with limit gauges, two laborers and a tally-man; the blocks are laid on a plank and gauged for length, then for width, and lastly for depth, the result being communicated to the tally-man; about 170 blocks per hour seems to be the rate at which the inspection proceeds, and the cost for each stone handled must be very nearly one cent. Of course, such a proceeding as this is entirely incompatable with "not more than two inspectors and one engineer."

As rapid a mode of inspecting paving blocks and at the same time sufficiently accurate, as is known to us, is the method adopted by Borough Engineer Deacon of Liverpool. which is as follows:—

From time to time four blocks as unloaded were placed side by side on a plank; a glance showed the variations from the standard height and length, and a gauge showed whether the blocks were of the proper thickness, the specification being that any four placed side by side should measure fully 12, and not more than 14 inches. It may be of interest to add that for the first year these blocks cost more than less carefully made ones, but after the first year there was only a small advance if any, in price. The use of these thin, deep blocks is extending in England, and the pavement lately laid on Ludgate Hill, London, very regularly had four blocks and three joints within 14 inches, thus making the best style of granite pavement now known.

It is generally thought that continued sweeping and ramming gravel into the spaces between the stones will thoroughly fill these spaces, keying the stones to one another so that they can be moved only with extreme difficulty and at the same time leave voids enough to permit the hot coal tar to reach the bedding sand and so render the pavement water tight, the necessity for which is ably set forth in the report. Driving the gravel into the cracks should not, we think, be practiced, since the caulking iron must pulverize the gravel and thus impede the flow of the hot coal tar, and it is brutal to have cracks wide enough for that purpose, as, the wider the cracks are the greater the tendency to "turtle backing" in the stones. This not only increases the noise of traffic and the power required for traction, but by presenting rounded surfaces to the horses' feet increases the number of falls and impairs their hauling power.

There is no doubt that, theoretically the conclusions against the use of coal tar in the joints are correct, but in Manchester, Liverpool and London, where these pavements were first used, the practice has been, and is continued, to use coal tar alone, or adulterated with about one-quarter asphaltum, the difficulty with pure bitumen being, that in summer it is apt to become too fluid.

Throughout his report Colonel Balch reiterates the necessity for intelligent, energetic and fearless supervision of work, saying "had the terms of every paving contract let in this city for the past six years been faithfully enforced we should have had smoother, firmer and more enduring carriage ways, far easier to clean, and hence better from a sanitary point of view, with a reduction of the repairs of at least one half what that cost has been, and is to-day." This is undoubtedly true, but he might well have added that such engineers as Smith, in charge of important work, are the natural progeny of such commisioners as Squire and Smith: while Squire is the natural issue of the corrupt bargains by the aid of which our affairs are managed, and there is small chance of contracts being faithfully enforced when a contractor can in Autumn notify the engineer and his assistant in charge of important city work that he will not commence the Spring with it, and show himself a true prophet.

Ne excuse can be made for the corrupt Commissioner and his following lately turned out of office; but we think the blame should not rest on "*first* THE ENGINEER: *next* THE CONTRACTOR: and *last* THE COMMISSIONER of PUBLIC WORKS," rather it should rest, first on the Statesmen who enacted the bill, next on the Governor who signed it and last on the Commission that so executed their trust as to develop the evil in it. The engineer in question is the result of the administration of the laws of New York by the city officials. Few could expect the contractor to take a philanthropic interest in the welfare of the city which no citizen shows, and the late Commissioner of Public Works—makes no more history here.

A Few Facts About Steam Boilers.

A boiler with any kind of mechanical details and arrangements, not absolutely faulty, can be proportioned to give the same evaporative efficiency as one of any other form.—*Charles E. Emery, Report Judges Group X X, Centennial Exhibition.*

Any test of a boiler at high pressure, with American anthracite coal and natural draft, which shows a result exceeding twelve pounds of water per pound of combustible should be discredited, at least until competing tests by a board of experts, such as the American Institute Fair or the Centennial tests, shall have shown that a higher result can be reached in practice.—*Wm. Kent, Van Nostrand's Engineering Magazine*, August, 1884. [This gives a black eye to many a boiler inventor-crank, and also to the boiler performance fraud.]

To heat economically and satisfactorily, by the direct system of steam heating and by the use of horizontal return-tubular boilers, buildings, such as abound in our great cities—we refer to buildings in which the street floor is a store, and the upper floors are devoted to sales and stock rooms and to light manufacturing, and in which the fronts are of stone or iron—a safe rule to follow is to supply 1 square foot of boiler heating surface for each 700 cubic feet, and 1 square foot of radiating surface for each 100 cubic feet of contents of building.—*Alfred R. Wolff, Building*, February, 1886.

The deterioration of all heating apparatus boilers is more serious from rusting in summer when idle than from wear in use. In fair service the duration of the shell of the horizontal, tubular boiler is from thirty to forty years, at least where water is employed that does not produce scale or deposit.—*Robert Briggs' "Steam Heating."*

In horizontal return-tubular boilers, fifteen square feet of heating surface, counting the external surface of tubes and only one-half the surface of shell of boiler, whether the gases return over the boiler or not, equal one

horse-power. Such boilers should develop the horse-power, or an evaporation of 30 pounds of water into dry steam from a temperature of feed of 100 degrees Fahr. and at 70 pounds gauge pressure, with a fuel consumption of 3.3 pounds of ordinary anthracite coal per hour. Since many modern stationary (mill and factory) engines require only in the neighborhood of 25 pounds of steam per horse-power per hour, it is by no means uncommon for steam engines in factories to develop the indicated horse-power with a coal consumption in boiler of 2.75 pounds per hour. When these results are not reached, it is frequently due to the fact that the most economical conditions of running possible do not exist, and inspection and tests on the part of competent steam engineering specialists seem advisable, and generally lead to changes, which secure an increased economy of the plant.

It always pays both as a matter of fuel economy and as adding to the durability of the boiler, to supply the feed water to boilers at a temperature of about 200 degrees Fahr. Good feed water-heaters of adequate proportions, utilizing the heat, of exhaust steam, readily secure this result.

It always pays to have all pipes, conveying live steam, covered by durable and effective non-conducting covering. Usually six months' saving in fuel exceeds the first cost of the job. Notwithstanding this fact, no defect is more common than to have steam pipes, not used for radiating heat, unprotected by non-conducting material.

It always pays to have ample chimney, boiler and engine capacity, for crowding of the steam plant is neither conducive to economy nor to durability.

In horizontal return tubular boilers, allow 15 square feet of heating surface for each horse power.

The draft area (or cross-sectional opening) of tubes should be about $\frac{1}{10}$ of the heating surface.

The draft area of flues should be about $\frac{1}{15}$ of the heating surface.

The grate surface should be about $\frac{1}{30}$ of the heating surface.

The following table, showing the draft area of different sized tubes and flues will be found convenient in calculation and design:

External Diameter of Tube or Flue, in Inches	Draft Area in Square Inches.	Draft Area in Square Feet.	Heating Surface in Sq. Feet per Foot of Length of Tube or Flue.	Number of Tubes =1 Square Foot of Draft Area.
⅝	.....	.....	.1636	.....
¾	.....	.....	.1963	.....
1	.575	.0039	.2618	250.0
1¼	.968	.0067	.3272	149.3
1½	1.389	.0096	.3927	103.7
1¾	1.911	.0133	.4581	75.2
2	2.573	.0179	.5236	55.9
2¼	3.343	.0231	.5891	43.3
2½	4.083	.0284	.6545	35.2
2¾	5.027	.0349	.7200	28 7
3	6.070	.0422	.7854	23.7
3¼	7.116	.0494	.8508	20.2
3½	8.347	.0580	.9.63	17.2
3¾	9.676	.0672	.9818	14.9
4	10.93	.0759	1.0472	13.2
4½	14.05	.0976	1.1781	10.2
5	17.35	.1205	1.3090	8.3
6	25.25	.1753	1.5708	5.7
7	34.94	.2426	1.8326	4.1
8	46.20	.3208	2.0944	3.1
9	58.63	.4072	2.3562	2.5
10	72.23	.5016	2.6180	2.0

In calculating the thickness of shell for a given diameter and working steam pressure, substitute in formula

$$T = P \times D \times .000075,$$

in which

T = thickness of shell in inches.

P = working steam pressure in pounds per square inch and

D = diameter of cylindrical shell, in inches.

The Proposed Main Sewerage System of Toronto.

We have just received an elaborate report on a proposed main sewerage system for the city of Toronto, Canada, made by Hon. W. J. McAlpine, C. E., and Kivas Tully, C. E., acting in conjunction with the City Engineer Mr. C. Sproatt.

The city of Toronto has a population of about 130,000 and the purpose of the present investigation, was to devise measures to prevent contamination of the waters of the harbor by sewage, and the fouling of the atmosphere thereby. The plan proposes a system of intercepting sewers, and the conveyance to deep water in the Lake. The aggregate costs of the two plans suggested are $1,115,100 and $1,624,665. The sewage is to be carried to deep water in two cast-iron pipes 5 feet in diameter, or by one steel pipe 7 feet in diameter, the latter pipe making a saving of $117,000 on the above estimates, and is recommended by the engineers. The report is accompanied by a large map, and full details of routes and cost of the various sections.

PERSONAL

AUSTIN CORBIN has been elected President of the Philadelphia & Reading R. R. Co.

H. A. HANCOX has resigned his position on the Hudson, Mass., Water-Works, to accept the position of Chief Engineer of the St. John Valley & River du Loup Railroad, New Brunswick.

C. A. SHAW, civil engineer, of Montreal, was severely burned in an accident on the Canadian Pacific R. R., 175 miles east of Winnipeg, Man., caused by the giving way of a trestle, on October 3rd.

ALBERT KRAUSE, City Engineer of Buffalo, is reported by the Albany *Evening Journal* to have been suspended by the mayor, pending the trial of the charges against him of neglect of duty and misconduct in office.

J. EDWIN CONANT, a well-known contractor of this city, died at Lowell, Mass., October 1st., at the age of fifty-six. He had been largely connected with the Chicago & Atlantic R. R., and with railroads in Florida and the Southwest.

MAJOR JAMES MORGAN, GEORGE F. SEITER, CHARLES DOLF AND CHARLES F. BLACKBURN, former members of the late Board of Public Works, Cincinnati, O., have been arrested, according to the Cincinnati *Enquirer*, on the charge of embezzling the city's money.

F. J. LOWE, a prominent railroad contractor and lumber merchant, of Texarkana, Texas, has made an assignment for the benefit of his creditors. The total amount of his liabilities is estimated at $150,000. The failure is due to procrastination on the part of the St. Louis, Arkansas and Texas Railroad Company in settling with LOWE for vouchers amounting to between $40,000 and $50,000, which he held against the company on account of construction.

HENRY P. FEISTER, M. E., the inventor of the wonderfully successful and ingenious perfecting printing press before referred to in this journal, has bought out the Franklin Machine Shop, of Philadelphia. MR. FEISTER was formerly superintendent of these same works, which were devoted to the manufacture of all manner of printing machinery, and will greatly enlarge upon the old plant.

ROWLAND MASON ORDISH, a prominent English engineer, died in London on September 12th. MR. ORDISH was born near Derby about 1827; after his arrival in London in 1867, the first important work he was connected with was the Victoria bridge over the Thames. He was afterwards connected as engineer with many works, including the roof of the Enoch Street station, Glasgow, the Amsterdam Crystal Palace, Dublin Exhibition, the Francis-Josef suspension bridge at Prague, the Albert suspension bridge, etc.

A. H. DAVIDSON, City Engineer of Augusta, Ga., has been for some weeks studying the methods of measuring and assessing the water power of Lowell, Mass., with the view of introducing a better system than now in use, at Augusta. MR. DAVIDSON does not consider the prospect of employment for engineers throughout the Southern States at present or in the immediate future, as especially encouraging MR. DAVIDSON left New York for home on Tuesday night.

O. B. WHEELER, U. S. Assistant Engineer, has started with a party of surveyors to survey the Missouri river from Fort Leavenworth to Glasgow, Mo. A secondary triangulation is to be made under the supervision of the Missouri River Commission. A party in charge of CAPT. WELLMAN will have charge of the leveling, and establishing permanent bench marks.

AM. SOC. C. E. At the regular meeting of the American Society of Civil Engineers, held October 6, the following gentlemen were elected to the several classes named in the Society:

FOR MEMBERS: Samuel George Artingstall, Assoc. M. Inst. C. E., City Engineer, Chicago, Ill.: George Birdsall Cornell, Chief Engineer, Brooklyn Elevated Ry., Brooklyn, N. Y.: Benjamin Lincoln Crosby, Resident Engineer, Rulo Bridge, Rulo, Nebraska: James Gustavus Dagron, Chief Inspector of Bridges, Baltimore & Ohio Railroad, Pittsburg, Pa.: Stephenson Waters Fox, U. S. Assistant Engineer and Chief of St. Joseph Division of the Improvement Works of the Missouri River, St. Joseph, Mo.: Frederick William Doane Holbrook, Superintendent Yellowstone Division, Northern Pacific Railroad, Glendive, Montana. George Anthony Lederle, Res. Eng., Omaha Bridge, Omaha, Neb.: Leonor Fresnel Loree, Engineer Maintenance of Way, 2d and 4th Divisions, Chicago, St. Louis and Pittsburg Railroad, Logansport, Ind.; Sampson Douglas Mason, Principal Assistant Engineer, Northern Pacific Railroad, St. Paul, Minn.: Robert John McClure, Consulting Engineer, Chicago, Burlington & Quincy Railroad, Denver, Colorado; James Henry Morley, President, Mary Murphy Mining Co., St. Louis, Mo.; Thomas O'Neill Morris, Engineer Maintenance of Way, Cincinnati, Indianapolis, St. Louis and Chicago Railway, Indianapolis, Ind.; Henry Cuyler Parsons, Engineer in the Department of the State Engineer; Alfred Petry, Assistant Engineer, Kentucky Central Railroad, Covington, Ky.; Hugh Tudor Richards, Res. Eng., Sonora Railroad, Guaymas, Sonora, Mexico; Francis Morris Rutherford, Assistant Supervisor, Amboy Division, Pennsylvania Railroad, Bordentown, N. J.; John Henderson Sample, Chief Engineer for W. V. McCracken & Co., having Location and Construction, Verdigris Valley, Independence and Western Railway, Kansas City and Southwestern Railway, and Kansas and Colorado Railway, Salina, Kansas; Julius William Schaub, Engineer in Charge, Dominion Bridge Co., Montreal, Canada; Richard Willette Sherman, City Surveyor of Utica, N. Y., and member of the firm Sherman & McDonough, contractors for public works, Troy, N. Y.; Miller Armstrong Smith, recently Assistant General Manager and Chief Engineer, Northern Railroad of Guatemala, now residing at Brooklyn, N. Y.; John Frothingham Ward, Consulting Engineer, New York City.

FOR ASSOCIATES,—Frank W. Handy, Architect and Superintendent of Construction, Cincinnati, Ohio; Robert Cochran McKinney, Secretary and Assistant Manager, Niles Tool Works and the Gordon and Maxwell Co., Hamilton, Ohio.

FOR JUNIORS: Edward Marshall Boggs, now engaged with Colorado Midland Railway, Colorado Springs, Colorado; Francis Dennis Hubert Lawler, Engineer, Iowa lines, Chicago, Burlington and Quincy Railroad, Burlington, Iowa.

CORRESPONDENCE.

The Fifth Avenue Pavement Report.

NEW YORK, October 8, 1886.

EDITOR ENGINEERING NEWS:

I have just finished reading the second report made by Colonel of Engineers George T. Balch in the *City Record* of September 28th, on the Progress made in Repaving Fifth Avenue. I cannot describe to you, Mr. Editor, the interest with which I perused the lucid explanation of the successful method employed by General Stone, the veteran Engineer-in-Chief of the Statue of Liberty, in laying the foundation mass of concrete for that monument of French art—the pleasure with which I read the deserved castigations of the ignorant peg setter employed through shameless or venal nepotism and noted the exquisite irony of always referring to him as "engineer"—the glow of professional pride with which I read of *esprit du corps*, professional experience, professional rules, professional morality, engineering knowledge, general intelligence, moral principles and exacting administrative methods guided by capacity and scientific knowledge. Nor the avidity with which I drank at the deep springs of information afforded by the citations of authority as to sand, gravel inspection engineering and surveying from Page, Dana, Van Cotta, Brande, Ure, "Notes on Building Construction," Rivington, London, Stormonth, Worcester, and Webster's Unabridged Dictionary, 1886.

I was a little "shook up" that any professional gentleman holding the beautiful ideas as to capacity and scientific knowledge enunciated by the distinguished reporter, should quote Webster for technical definitions. But I was not thoroughly shocked until, trying to add to my stock of valuable knowledge as to the economic products resulting from the destructive distillation of coal tar, I collated his remarks on that head in "Exhibit U," with an article I had noted in your issue of August 28, 1886, on that subject and found that while Col. Balch had altered the text slightly, leaving out, by the way, the most interesting item, he had copied a proof reader's mistake as to the tinctorial power of one of the dyes, viz.:

1. Magusta, 500 yards of flannel 27 inches wide.

Now without stopping to inquire what possible connection 500 yards of red flannel 27 inches wide, can have with the question as to whether the city of New York is paying "Mat Beard" for a sham first-class pavement or not, I would like to inquire as to the engineering or scientific knowledge, or general intelligence exhibited by Colonel Geo. T. Balch, who, not knowing that there is no dye called Magusta, but there is one called Magenta, loaded the *official* City Record of this intelligent City of New York, with an official statement that Magusta will dye 500 yards of flannel 27 inches wide; all about the pavement of Fifth avenue. And the same copy of the *City Record*, records the voting of $5,000 additional to the use of the commissioners of accounts, as the money was needed to carry them through the year.

I do not wish it to be understood that the writer wishes to uphold either of the Smiths, for since Mayor Ely's appointment of shameless Park Commissioners who discharged an able engineer and his assistants from the charge of the Riverdale Parkway, and appointed the incarnation of ignorant inefficiency with the resulting loss to the city, it is doubtful if anything as bad as the arrangement between Squire, Beard and two Smiths has been perpetrated.

The word engineer has been so abused in the report under consideration, that I will sign myself simply

CIVIL.

Tests of American Portland Cements in Europe.

NEW YORK, October 6.

EDITOR ENGINEERING NEWS:

In your issue of Sept. 25th, Vol. XVI, No. 39, the article on "Tests of American Portland Cements in Europe," two errors have crept in. In the body of the report it should read 454 pounds, instead of "seven day tensile strain per square inch to be 554 pounds." Again, in table of the twelve months test, the average test is 784 pounds and *not* 754 as printed. Please correct and oblige. Yours,

JAS. BRAND.

The Underground Wire Problem.

BY S. S. WHEELER.

Written for ENGINEERING NEWS.

The placing of electric circuits underground aggravates so many troubles that are trifling and unnoticed with aerial circuits, that various methods of protecting the wires, and of insuring their operativeness have to be employed. Thus it is that experience in laying aerial lines is of little or no assistance in engineering for underground wires. Single wires, and cables of definite numbers of wires have been laid and some of these are successful; but no system has ever been established which is sufficiently comprehensive and at the same time flexible enough to provide for all the wires we have in our streets, without subjecting some of the companies using them to restrictions in regard to their wires, which would kill their business. This is the ultimate difficulty at which we shall arrive, if we analyze the whole subject and consider the remedy for each particular fault.

Lines hung in the air need only two things—insulated supports and plenty of room. They are surrounded by air, the best of all non-conductors; they are far apart, whereby induction is avoided. They may have connections made with them quickly at any point. They may be hung with or without covering and be of any size.

When placed underground all of these advantages are lost, and must be replaced, so to say, artificially. The means for doing this, together with the requirements of underground work, which, being non-electrical, we will not consider in detail, may be divided into three classes: the electrical and the mechanical requirements of the wires and the requirements of the conduit. As the present question relates to burying a great many wires, in a way that permits frequent changes, we will consider only the requirements of wires when placed together in large conduits.

The two electrical difficulties to be overcome in burying wires are entirely distinct matters, and in regard to this distinction there is a great deal of ignorance.

One of these difficulties is leakage. This is overcome by good insulation. Bad insulation of a wire corresponds to the porosity of an earthern pipe, which has to convey a fluid a long distance, efficiently. Insulations are not absolute; consequently, the longer the line or the greater the pressure, the better the insulation required, or the greater the loss of current before reaching the end of the line.

The other difficulty is induction. This is a curious manifestation of electrical action, by which the signals which are sent through a wire are more or less faintly reproduced in a neighboring wire, but this is not due at all to leakage, and there is no direct passage of current to or from either wire. It is sometimes popularly described as a sympathetic irritation. One of the most familiar instances of it is the buzzing heard in telephones. In other forms, under the names of retardation and interference, it is the chief obstacle to long distance telephoning and ocean telegraphy. This trouble is very much increased in underground wires, because they are necessarily very much closer together, the induction increasing inversely as the *square* of the distance between the wires. The induction is also increased by the presence of a good intervening insulator necessary to keep out water and prevent electrical leakage.

As induction is in no way a leakage, it is not remedied by good insulation, but depends upon the power to transmit induction of the substance lying between the wires, whether it be air or a solid. This property is known as specific inductive capacity. Unfortunately, the substances which transmit induction the least, are the poorest insulators. For example, resin and pitch transmit only one-third as much induction as gutta percha; but gutta percha is a much more effective insulator than resin or pitch. And in a general way, it is the same with all substances—the best insulators giving the most trouble from induction. The single exception to this rule is air, which is the best insulator known except when damp, and at the same time causes very little induction. Air transmits less induction than pitch, or any other solid insulator. These facts doubly augment the trouble caused by having wires bunched close together in a conduit.

The mechanical requirements of the wires are, that they be sufficiently pliable to be placed in the conduits; that they be covered with insulation sufficient to protect itself in case of abrasion of the wire, (which is very liable to occur) and still preserve enough of itself, to electrically insulate the wire. They must not corrode. They must be laid or arranged so as to be easily identified, and must be led to places convenient for making and changing connections. The requirements of the conduit are, that, it should be of non-conducting material, and such as not to destroy the insulation of the wires; it must be impervious to water and dry, able to resist strains and pressure, large enough to hold all additional wires, and induction-preventing devices and to permit antagonistic wires to be laid far enough apart to prevent electrical disturbance, and must be readily accessible at frequent intervals to connect and change wires.

Each of these points individually can be met, but as far as our experience goes, not without interfering with some of the others. The question is: Can a system be devised and carried out which will meet all these points?

There is no difficulty about insulation if the wires are laid in a perfectly dry place. But can any underground passage be kept so dry that an ordinary cotton covering will not absorb moisture? If not, each wire must have a waterproof covering, for if moisture soaks into contact with the bare wire, it will invariably be decomposed by the electricity into gases, which are corrosive and explosive. Wires which are portions of long lines must be allowed to touch only the very best insulators.

To overcome induction, innumerable devices have been made, the best and largest class of which work by neutralizing each induced impulse by one exactly equal to it, generated by the same disturbing wire, and caused to travel in the opposite direction in the disturbed circuit, and oppose its mate. To do this, coils have been connected to the disturbed and disturbing lines at the stations to generate impulses, duplicating and neutralizing those generated on the line. But unquestionably the simplest and best way of accomplishing it, is to lay for one of the wires a returning wire back over the entire route, the outgoing and incoming wires of the one circuit being occasionally twisted, so as to be on the average equally distant from any dangerous and disturbing wire. The effect of this is, that while all regular currents may flow round and round this circuit, if the neighboring wire induces a current in one of the pair, it induces an equal current in the other in the same direction, and these flow on till they meet and kill each other at the end. The same prevention is secured by laying a return wire for the disturbing wire, and leaving the others single, for then the impulse induced in any line by one wire of the disturbing circuit is neutralized by the impulse generated in the opposite direction by the other wire of the disturbing circuit.

Single wires and cables in lead tubes have been laid in several countries of Europe with success; but these do not provide for additional wires, and for the first increase of service a new trench must be dug. They cannot stand disturbance, and in New York they would be quickly destroyed in opening the streets for other work.

In this country, wires have been laid in iron pipes filled with an asphaltic mixture and sealed, each length of pipe being plugged at both ends, and the wires allowed to project a few inches into a coupling box which clamps the ends of two sections of pipe, the wires being joined in the box, and the box filled with the mixture, and then sealed. These tubes form probably the most perfect system for its uses ever designed, working perfectly for their purpose, incandescent electric lighting. They are of course more durable than the lead-covered wires in places where the ground is disturbed by excavations, but the method does no provide for laying new wires.

The plan of laying a large duct with occasional boxes in which the men can work and draw the wires through the duct is the next in degree of perfection, and is the simplest plan which will allow additional wires being laid without opening a new trench. This plan has been in use in London very successfully there being one large iron pipe laid along the side walk and small boxes let into the pavement at suitable intervals through which the wires are accessible.

A slight modification of this is the substitution of a number of smaller tubes for the one large one, which permits a safer classification of wire according to the intensity of their currents, and permits each operating company to have exclusive control of its own duct. Such systems have been laid for small numbers of wires in several cities with considerable success. But these conduits make it impossible to lead a wire to a building without running it from one of the drawing-in holes, and to do this in the case of an electric distribution system such as an electrical light system for houses or even streets, would require more wire to be run outside of the conduit to reach all of the lights from the drawing-in boxes than would be required to run the whole circuit in the old way.

By having their own systems of wire-laying, without being required to use something that would also be suitable for other companies, the Edison Co. successfully laid a network of conductors and house service pipes connecting every house within nearly a mile square with their electrical station, all at a cost which allows them to carry on a business, and without showing a wire above the surface. This could not be done if they were compelled to use a drawing-in conduit, suitable for telegraph lines. In some cases they use copper conductors as large as a man's wrist, and they require branch connections to houses every twenty feet. How could a district telegraph circuit which is looped into every house on a block be laid in an underground conduit, the junction boxes of which are 400 feet apart

The conclusion is that while it is perfectly possible to lay wires underground, as has been done to a limited extent in many places, no one system is sufficiently elastic to take in all wires and permit their being connected to, where needed, except a system of laying all wires in a net work of passages running under each street and large enough for men to pass through making connections in front of the buildings and paying the branch wires out through openings cut through the wall of the viaduct. This is of course an enormously expensive plan, and the demand has not yet reached a point to warrant the outlay.

Any other plan chosen will have to be supplemented by one or more others for the stragglers, who cannot conform to it. Considering the limitations to expense, the number and variety of wires to be accommodated, and the state of the art, the commission has made a remarkably wise selection in adopting the drawing-in system, it being of any capacity and next in perfection to the most expensive plan.

LITERATURE.

Treatise on the Theory of the Construction of Helicoidal Oblique Arches. By JOHN L. CULLEY, C. E. Van Nostrands Science Series, No. 87, Price 50 cents.

In this little book the author has taken especial pains to simplify the question and treatment of oblique arches, and divest the engineer of the idea that their construction is unduly difficult and intricate. The theory is first discussed and is followed by a description of the patterns and their application to the members of the arch. Logarithmic and ribbed oblique arches are also described; and the whole treatise is illustrated by excellent diagrams.

Theory of Magnetic Measurements, with an Appendix on the Method of Least Squares. By FRANCIS E. NIPHER, A. M., Professor of Physics in Washington University, New York, D. Van Nostrand, Publisher, 1886.

This little volume of ninety-four pages, treats of the theory of the precise observations carried on in a magnetic observatory, and is intended as a supplement to the instructions of the Coast and Geodetic Survey on that subject. It does not deal with the common methods used by surveyors for determining the declination of the needle, but with these precise operations which require the investigation of the moment of inertia of the magnet, with the corrections for torsion, temperature, etc. The great and growing importance of electrical and magnetic measures will commend the work, especially as its author is well known as an expert of high authority in such matters. The twelve pages on the method of least squares, will prove useful to those who have no acquaintance with this important method for the adjustment of observations.

The Civil Engineer's Field-book; designed for the use of the Locating Engineer. Containing tables of Actual Tangents, and Arcs expressed in chords of of 100 feet for every minute of intersection, from 0° to 90°, from 1° curve to 10° curve, inclusive; also Tables of formulæ applicable to Railroad Curves and the Location of Frogs; together with Radii, Long Chords, Grades, Natural Tangents, Natural Sines, Natural Versed Sines, Natural External Secants, etc. With Explanatory Problems. By EDWARD BUTTS, C. E. John Wiley & Sons, publishers, New York, 1886; size, 4 × 6¼ inches, pp. 270. Price, $3.00.

The title of this book is so expressive of its contents and general character that it leaves little to be said in that respect. The work is a monument of patience on the part of the author, and should prove a labor saving investment to the purchaser. It is a "Henck" elaborated and this is quite recommendation enough—to the practicing engineers.

Engineers' Surveying Instruments,—Their Construction and Use.

IV.

Written for ENGINEERING NEWS.

BY I. O. BAKER, C. E. PROFESSOR OF CIVIL ENGINEERING UNIVERSITY OF ILLINOIS.

(*Continued from Page* 199.)

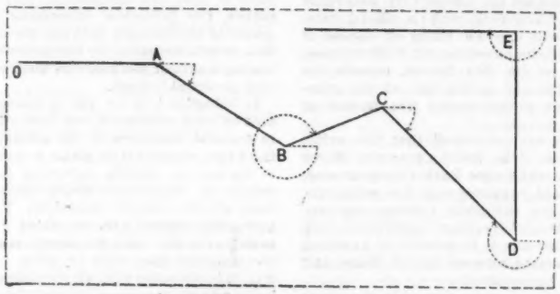
8. PRACTICAL HINTS.—The beginner should not neglect the preliminary matters of planting the tripod, bringing the plumb-bob over the point, and leveling the instrument. There is great difference in the skill and rapidity with which different persons will set up the transit; generally there is an unnecessary waste of time and hard labor. A very neat way of doing it is as follows: tighten the screws in the upper end of the legs, until friction will just hold them wherever placed, open them until they make an angle of about 30° with the vertical; let down the plumb-bob, and set the instrument over the point, a gentle pressure on the legs of the tripod brings the plummet over the point, and a slight movement of the leveling screws brings the plate level.

Some engineers seem to think that the harder the tripod legs are focused into the ground, the tighter the leveling screws are, and the tighter the instrument is clamped, the more accurate the work, but the contrary is more nearly true. An instrument keeps it adjustments better and works more kindly, when handled delicately.

If the instrument is not firm, examine the tripod-head, and the iron shoes on the legs, to see that they are not loose; no instrument can stand firm with any looseness in these parts. The clamps and tangent screws should be examined to see that they are not loose. The instrument may slip on the lower plate, owing to the leveling screws not being tight enough.

If the observer has clearly in mind what he is trying to do, and thoroughly comprehends the effect of possible errors, in his instrument, he can save much time and trouble, thus leaving himself free to give his attention where it will do the most good. For example, a great deal of time is often wasted in getting the instrument precisely over the point; the case should vary inversely as the distance of the object sighted at; an inch may cause an error of three seconds if the object is a mile away, but an error of three minutes at 100 feet. The position of the instrument from the point, with reference to the object sighted at, affects the value of the resulting error.

It is a waste of time to level up accurately, each time, regardless of the kind of work to be done; if only the horizontal angles between points on the same level, are to be found the instrument can be leveled with sufficient accuracy by the eye alone; if only vertical angles between points in the same vertical are desired, only the level parallel to the telescope need be read. On the other hand, in measuring a horizontal angle between a high and a low point, the level perpendicular to the telescope should be very carefully attended to. So in all instrumental work, there are certain operations which should be carefully attended to while to attend equally carefully to others would be only a waste of effort.



Traversing. (*See page* 237).

10. Nothing need be said here concerning the adjustment of the instrument or its ordinary manipulation.

MEASURING ANGLES ACCURATELY.—It sometimes happens that an engineer desires an angle with the utmost accuracy. There are two methods of making the observations, when extreme accuracy is desired; they are *by series* and *by repetition*. One or the other of these methods is always used in measuring the principal angles of the goedetic triangulation. The principles involved are useful in less accurate work.

BY SERIES.—Sight upon the first station, and read both verniers; this eliminates eccentricity. Sight upon the next station to the right, and read as before; continue on around the horizon, reading upon each station, and close by reading upon the first station again; if the last reading is the same as the first, it proves that the instrument did not slip or get moved. Reverse in altitude and azimuth, move the lower motion a little to eliminate personal bias, and read upon the first station; proceed around the horizon toward the left, reading upon each station and closing upon the first. The reversal in azimuth and altitude eliminated eccentricity of line of sight, error of telescope slide, and inclination of horizontal axis. Reversing the direction around the horizon eliminated any twist of the tripod. Shifting the horizontal circle diminished the possibilities of accidental error of graduation. The above observations constitute one "set."

To secure greater accuracy by increasing the number of observations and also to eliminate periodic errors of graduation, shift the horizontal circle an aliquot part of the distance between verniers, and take another set. The amount that the circle should be shifted between sets is equal to the distance between verniers divided by the number of sets to be taken. The mean of the observed values is true angle.

BY REPETITION.—Sight upon the first station, read both verniers; with the upper motion, turn to the next station, and read as before, (this last reading is only for a check); with the lower motion turn back to the first station, the reading remaining unchanged; then unclamp above, and turn forward again to the second station. The angle will now have been measured a second time, but on a part of the circle adjoining that on which it was first measured, the second beginning where the first ended. This operation may be repeated any number of times; read the circle after the last sighting upon the second point; the difference of the first and last readings, divided by the number of repetitions gives the angles more precisely than a single observation would. Notice that the vernier need be read only at the begining and end, although the second reading, as above, is a valuable check in determining how many time 360° should be added to the last reading, in case the vernier has passed 0°. Next reverse in altitude and azimuth, and measure the angle as before, beginning however at the second station. This eliminates all error of adjustments and reduces the errors of observation by increasing their number. Of course, the mean of the observed values is assumed to be the true angle.

COMPARISON OF METHODS.—Both methods seem to be about perfect, as far as the elimination of errors of adjustments, of graduation, and of observation is concerned. The method by series is preferred by most observers, for triangulation work; its peculiar advantages can be fully realized only with the precise instruments used in that kind of work. With ordinary engineering instruments, there is an obvious limit beyond which it is useless to multiply observations by this method.

The method by repetition was once a great favorite with the best engineers, especially the French, for triangulation work; but the improvements in the manufacture of angle instruments, has given preference for the most accurate work, to the method by series. However, the method by repetition is peculiarly suited to the precise measurement of angles with a coarsely-divided circle, as, for example, a common engineer's transit. The principle of this method is certainly very beautiful, but its accuracy is largely dependent upon the freedom with which the instrument turns on its centers, and upon the stability of the clamp and tangent screws. Under ordinary conditions, the limit of this method is reached after a few repetitions.

TRANSIT SURVEYING.—Unfortunately, there is no generally accepted method of doing transit work, either for the field work or for recording the results. Three methods of more or less general use among engineers will be considered. The first, for want of a better name, we will call the *angle method*; the second can appropriately be called the *quad-*

rant method; and the third could appropriately be called the *full circle method*; but as this method of surveying has been called *traversing*, we will use that term and not attempt to introduce a new one.

1. ANGLE METHOD.—This method consists in measuring and recording the angle which each line makes with the preceding one. The angle measured may be the one included between the two lines, or the angle between the second line and the first produced. In the latter case, the telescope is sighted along the first course, the vernier read, and the telescope transited; the telescope now points in the direction of the first line produced, it is next turned to the second line, and the vernier read; the difference of the readings, *i. e.* the angle swept over, is equal to the angle between the first course produced and the second. This angle is sometimes called the angle of deflection.

2. QUADRANT METHOD.—The distinguishing characteristic of this method is the manner of designating the observed horizontal angles with reference to the quadrant in which the enclosing lines belong. The angles are read and recorded as bearings, just as in compass surveying. The meridian through the first station is obtained by reading the needle, or by sighting upon some line whose bearing is known, or it may be assumed; the object of such surveys is generally not so much to get the *true* bearings, as to get the relative bearings accurately. The bearing of any succeeding line is found by measuring the angle which it makes with the preceding line produced, and adding it to or subtracting it from, the bearing of the preceding line. This method is doubtless a relic of the time when the compass was the common angle instrument. The 0° to 90° numbering on the horizontal circle is especially useful in this system.

3. TRAVERSING.—Traverse surveying, or running a traverse, or simply traversing, is conducting a survey in such a way that the readings of the plate will show the angles which each line of the survey makes with any chosen reference line. Although the essential principles of this method are used to a limited extent, there is no agreement as to the details of the process. Even the term *traversing* is not always used as defined above. This method could appropriately be called surveying by the back azimuth, or surveying by the back angle, or surveying by carrying the azimuth.

To run a traverse, set the instrument up over the first station, *i. e.*, the end of the first course. For the present we will assume that the first side is to be the reference line, *i. e.*, the meridian of the survey. Set vernier *A* at 0°, clamp the upper motion, and turn the telescope upside down, with the lower motion, direct the line of sight to the other end of the first course; transit the telescope, loosen the upper motion; sight upon the next station, and read vernier *A*. Move to the next station, loosen the lower motion, level up, invert the telescope, and glance at the reading to see that it has not changed; sight upon the last station; using the lower motion. Invert the telescope, loosen the upper movement, sight upon the next station, and read. Proceed in like manner for any number of lines. Each reading is the angle between its corresponding course and the first one. Below are the notes and plan of a traverse survey, as above.

Station.	Back-Sights	Fore-Sights	Dist.	Remarks.
A	0° 00′	35° 52′		
B	35° 52′	340° 31′		
C	340° 31′	41° 08′		Angles read from ver. *A*.
D	41° 08′	270° 00′		
E	270° 00′	180° 00′		

The instrument was first at *A*, the line 0*A* being regarded as the first course. The vernier was set at zero, and a back sight taken to 0′; it is recorded opposite *A*, in the back sight column. The telescope was then transited, the upper motion loosened, and the telescope directed to *B*; the reading of this line, 35° 52′, being recorded as in the table. After the instrument is removed to *B*, and the back sight taken up on *A*, the vernier is to be read to make sure that it has not been changed; the record of this reading is made in the back sight column. The writing of this down will be evidence that the reading of the vernier was checked; in actual work this will be found to be an important check against errors, as, for example, turning the wrong tangent screw or reading the wrong vernier. The angles marked in the diagram are the corresponding angles of the fore sight column in the table.

Instead of making the first course the reference line, as above, we may take any other line as the meridian or reference line. In this case, the instrument is first set up at the point of beginning, the vernier set at zero, and the first back sight made in the direction of the meridian; the remainder of the field work and the record is as before.

It makes little or no difference whether the first back sight is made towards the north or south end of the meridian; but a note in the remarks column should show which way it was made.

This method of using the transit is specially convenient in railroad surveying.

COMPARISON OF METHODS.—In the time required for the field work, there is very little difference between the three methods; the second and third require less than the first. The quadrant method is simple and easy enough to understand; but, in field work, in the computations, and in the plotting, there will be found many drawbacks and many opportunities for errors, which do not exist in the full circle system. One of the chief objections to the quadrant method is that four different directions are designated by the same angle numerically. As the advantages of the full circle system are better understood, it will be more fully adopted; as yet it is only used to a limited extent.

SOURCES OF ERRORS.—The sources of the errors of transit work may be classified as follows: 1. Errors in setting up; 2. of sighting; 3. of manipulation; 4. of adjustment; 5. of reading.

1. The plates of the instrument may not be placed horizontal and the instrument may not be set up over the point about which the angle is desired or over the point previously sighted at; in anything like good work, these errors will be inappreciable.

2. ERRORS OF SIGHTING.—If a flag-pole is sighted at, it may not be vertical; therefore, sight as low upon it as possible. The intersection of the cross-hairs may not exactly cover the point; this is due to lack of care or to parallax in the instrument, and in either case, the remedy is obvious. It is not enough to bring some point of the vertical hair over the point, for the hair may not be truly vertical.

ERRORS OF MANIPULATION.—The wrong tangent screw may be turned; this is a fruitful source of error, and one difficult to discover and impossible to correct. If the tangent screw has back lash, the instrument must be handled so as to prevent it; error from this cause sometimes is produced by the instrument turning on the ball and socket joint owing to the foot screws not being screwed up tight enough. The upper part of the instrument should move so freely as not to twist the tripod.

ERRORS OF ADJUSTMENT.—The points to be considered are eccentricity, equality of standards, straightness of telescope slide, and adjustment of cross-hairs. The eccentricity is always small and easily eliminated by reading two verniers. The equality of the standards can effect only the horizontal angles between high and low points, and in ordinary practice it will be inappreciable.

The straightness of the slide and the adjustment of the cross-hairs are closely related; neither will produce error either in measuring horizontal angles between points equal distances from and equal distanaces above vertical angles between points or below the instrument, or in measuring equally distant from the instrument. An error of adjustment of the line of collimation produces an error of double amount in traversing, or in prolonging a line by back and foresights. If great accuracy is desired in either of these operations, the telescope should be reversed on each alternate back-sight and fore-sight. All errors of adjustment can be eliminated by reversing, making a second observation and taking the mean.

ERRORS OF READING.—Errors may be produced by reading the wrong vernier, the wrong end of a double vernier, the wrong row of numbers, or by reading 28° instead of 32°, etc., or by forgetting to add the ½ degree of the line to the reading of vernier and recording 20′ instead of 50′ etc.

LIMITS OF PRECISION.—It is a little difficult to get sufficient data for a satisfactory discussion of this subject, without making observations specially for this purpose, which is not desirable. The sophomores, '86, in the prosecution of the ordinary class work in topographical surveying, measured the angle of ten triangles; the sums of the three angles should in each case equal 180°. The length of the sides varied between 400 and 1,200 feet; the conditions as to time, targets, etc., were about those of actual practice. The instrument read to minutes, and certainly was not the best. All the errors enumerated in the preceding article were involved. This work gives the probable error of a single direction = 32 seconds; the probable error of an angle = 50″; the probable error in the sum of three angles of a triangle = 86 seconds. The maximum error in the closing of a triangle was 3¼ minutes.

The same class in measuring the four angles around a point and the three angles of a triangle, using chaining pins for targets, with sights about 100 feet long, obtained results about half as large as those above. The results of traversing, with flag-poles for targets and sights varying between 200 feet and 800 feet, gave results a little greater than half those of the preceding paragraph. This is all the data at hand to show the degree of accuracy attainable, but in a general way it is believed that the above results are not exceptional.

A transit is sometimes used to determine areas. The legitimate error in the balancing of the latitudes and departures in transit surveying can be discussed as in compass surveying;† the formula deduced for that case are applicable to transit surveying. Such a discussion shows that ordinary work with the transit is proportionally as accurate as the best chaining. Therefore, in finding areas by the transit, the greatest care must be given to the chaining.

ENGINEERING NEWS, Three Months, One Dollar and Fifty Cents.

†ENG. NEWS Vol. XIV page 278.

The Proper Dimensions of Chimneys.—CORRECTION. (*See Page 217, Ante*).

Table Showing Sizes of Chimneys for Steam Boilers.

Diameter of round Chimney, in inches	HEIGHT OF CHIMNEY.											Side of square Chimney, in inches
	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.	110 ft.	125 ft.	150 ft.	175 ft.	200 ft.	
	Commercial H. P. of Boiler.											
18	23	25	27	.....	.....	.....	.....	.....	.....	.....	.....	16
21	35	38	41	.....	.....	.....	.....	.....	.....	.....	.....	19
24	49	54	58	62	.....	.....	.....	.....	.....	.....	.....	22
27	65	72	78	83	.....	.....	.....	.....	.....	.....	.....	24
30	84	92	100	107	113	.....	.....	.....	.....	.....	.....	27
33	.....	115	125	133	141	.....	.....	.....	.....	.....	.....	30
36	.....	141	152	163	173	182	.....	.....	.....	.....	.....	32
39	.....	.....	183	196	208	219	.....	.....	.....	.....	.....	35
42	.....	.....	216	231	245	258	271	.....	.....	.....	.....	38
48	.....	.....	.....	311	330	348	365	389	.....	.....	.....	43
54	.....	.....	.....	.....	427	449	472	503	551	.....	.....	48
60	.....	.....	.....	.....	536	565	593	632	692	748	.....	54
66	.....	.....	.....	.....	.....	694	728	776	849	918	981	59
72	.....	.....	.....	.....	.....	835	876	934	1023	1105	1181	64
78	.....	.....	.....	.....	.....	.....	1038	1107	1212	1310	1400	70
84	.....	.....	.....	.....	.....	.....	1214	1294	1418	1531	1637	75
90	.....	.....	.....	.....	.....	.....	.....	1496	1639	1770	1893	80
96	.....	.....	.....	.....	.....	.....	.....	.....	1876	2027	2167	86

The Century's Rise of Wages.

Discussing wages, in one of his lectures before the students of Harvard University, Professor Thompson gives many facts of curious interest. In 1793 the Schuylkill and Susquehanna Canal Company advertised for workmen, offering $5 a month for the winter months, and $6 for summer, with board and lodging. The next year there was a debate in the House of Representatives which brought out the fact that soldiers got but $3 a month. A Vermont member, discussing the proposal to raise it to $4, said that in his State men were hired for £18 a year, or $4 a month, with board and clothing. Mr. Wadsworth, of Pennsylvania, said: "In the States north of Pennsylvania the wages of the common laborer are ont, upon the whole, superior to those of the common soldier." In 1797 a Rhode Island farmer hired a good farm hand at $3 a month; and $5 a month was payed to those who got employment for the eight busy months of the farmer's year. A strong boy could be had at that time in Connecticut at $1 a month through those months, and he earned it from working from daybreak until eight or nine o,clock at night. He could buy a coarse cotton shirt with the earnings of three such months. The farmers could pay no better, for the price they got for produce was wretched. Butter sold at eight cents a pound, and when it rose suddenly to ten cents several farmer's wives and daughters went out of their minds with the excitement. Women picked the wool off the bushes and briars, where the sheep had left it, and spun and knit it into mittens to earn $1 a year by this toilsome business. They hired out as help for twenty-five cents a month and their board. By a day's hard work at the spinning-wheel a woman and a girl together could earn twelve cents. As late as 1821 the best farm-hands could be had for twenty-five cents a day, or twice as much in mowing time. Mathew Carey, in his Letters on the Charities of Philadelphia (1829), gives a painful picture of the working classes at that time. Every avenue to employment was choked with applicants. Men left the cities to find work on the canals at from sixty to seventy-five cents a day, and to encounter the malaria, which laid them low in numbers. The highest wages paid to women was twenty-five cents a day, and even the women who made clothes for the arsenal were paid by the Government at no higher rates. When the ladies of the city begged for an improvement of this rate, the Secretary hesitated lest it should disarrange the relations of capital and labor throughout the city. Poor people died of cold and want every winter in the city, and the fact seems to have made an impression only on benevolently disposed persons like Mr. Carey.—*American Architect.*

Experiments with Respect to the Dry-rot Fungus (*Merulius Lachrymans*).*

Professor Dr. Meidinger states that Professor Poleck has discovered that the timber procured for him purporting to be winter-felled wood, was in reality raft-timber, floated down the river, and he has ascertained that timber which has been thus immersed is no longer liable to the attack of dry rot. So much so is this the case that in Alsace it is customary to specify that only raft-timber shall be employed. The water slowly dissolves out the albumen and salts, and thus deprives the fungus of the nutriment needful for its development. A French savant has found by experiment that whereas fresh sawdust, when buried in damp earth rots away in a few years, sawdust which has been soaked for some time in water, and has been thereby deprived of soluble matters, will remain in the ground under similar circumstances, wholly unchanged, and only slightly tinged on the exterior with earthy matters dissolved from the soil.

Cylinder Capacity and Cost of Steam Engines.

The following table, prepared by Mr. Charles H. Fitch, for the records of the Tenth Census, shows the comparative relations of cylinder capacity, weight, and cost in steam engines of the horizontal, plain, slide-valve type, rated at from 8 to 100 horse power:—

Cylinder Capacity of Engine. In cub. feet.	Ratio of Stroke to Diameter.	Price per cubic foot of Cylinder. In dollars.	Weight of Engine per cu. ft. of Cylinder. In pounds.
0.19	2.00	1,910	8,684
0.27	1.71	1,392	6,296
0.46	2.00	1,130	7,500
0.59	1.77	952	7,118
0.73	1.60	872	6,944
0.90	2.00	749	6,264
1.31	1.66	707	6,183
1.58	2.00	644	5,860
1.79	1.43	633	5,168
2.14	1.71	569	5,023
2.79	1.50	497	4,337
3.48	1.87	451	4,253
3.53	1.33	509	5,241
4.41	1.66	448	4,736
4.35	1.20	517	4,638
5.44	1.50	459	4,964

To obtain the capacity of engine cylinder in cubic feet, multiply .7854 times the stroke of engine, in feet, by the square of the diameter of cylinder, in feet.

Earth Temperatures.

A remarkable example of the increase of temperature in the earth toward the center has been presented at Pesth, where the deepest artesian well in the world is that now being bored for the purpose of supplying the public baths and other establishments with hot water. A depth of 951 m —3120 feet—has already been reached, and it furnishes 800 c. m.—176,000 gallons—daily, at a temperature of 70° C.—158° F. The municipality have recently voted a large subvention in order that the boring may be continued to a greater depth, not only to obtain a large volume of water, but at a temperature of 80° C.—176° F. It is suggested that it is thus within the bounds of probability that the time may come when a brewer will obtain his water supply from a well of sufficient depth to yield "liquor', at the mashing temperature.

*Abstracts; Inst. Civil Engineers.

The 1,000-foot Tower of Trevithick.

In connection with the tower 1,000 feet high which it is proposed to erect at the Paris Exposition of 1887, the fact has been unearthed that Trevithick, the English engineer, as long ago as 1832, proposed to build a tower of similar height in honor of the passage of the Reform Bill.

His plan, as outlined in *The Morning Herald* of July 11, 1832, proposed a tower 1,000 feet high and 100 feet in diameter at the base and 12 feet at the top. It was to be made of cast-iron in 1,500 plates of 10 feet square each and perforated with holes 18 inches in diameter to reduce the weight; the plates were to be flanged and connected by bolts. The total weight of the material was estimated at 6,000 tons and the iron-founders had guaranteed to furnish the metal for $35,00 per ton delivered.

In the center of the column was to be a tube 10 feet in diameter and in this was to work a closely fitting piston provided with seats for twenty-five persons. This platform was to be lifted by the action of compressed air at the rate of about 3 feet per second. In decending, a regulating value was to be opened and handled in such manner as to prevent a too rapid descent.

This scheme was submitted to William IV on March 1, 1883; but as Trevithick died suddenly on the 22nd of April following, the project fell flat. Mr. Eiffell of Paris, now proposes to carry out a similar scheme, but on modern principles and with modern material.

WATER

A WATER SUPPLY ASSOCIATION.—A Society of Railroad Water Supply Superintendents has been organized in Cedar Rapids, Ia., for the consideration of all matters pertaining to hydraulic engineering as applied to railroad service. Office of Secretary, 171 South Sixth street, Cedar Rapids, Ia.

LEEDS, ENGLAND.—The water-works committee of the corporation have recommended the adoption of the scheme of Messrs. Filliter and Rofe, civil engineers of that city, for a new tunnel in connection with the borough water-works at an estimated cost of $37,700. Another scheme involved an extension at a cost of $90,000.

THE HYATT WATER FILTER.—The City of Eau Claire, Wis., is putting in a plant to purify 1,000,000 gallons of water per day. The Western Steel Work Co., St. Louis, Mo., has a plant of its own, with a capacity of 650,000 gallons daily; their first order was for a filter of 150 gallons capacity, and after six months trial they gave their order for the additional plant. The New York State Reformatory, at Elmira, N. Y., is putting in a plant to filter all the water used.

HILLSBOROUGH, N. H.—Parties in Springfield, Mass., have taken the contract to put in the new water-works. The source of supply is Loon pond, four miles from the town, from which there is a fall of 350 feet. A reservoir will be built on Bible hill, a mile and a half from the town, from which there will be an available head of 150 feet.

EAST BOSTON, MASS.—Dr. M. B. Leonard advocates the construction of a separate sewerage system for the district, consisting of a main pipe from Eagle square to Sampson's wharf, with two branches. It is proposed to construct a pumping station on the wharf, with a 2,500 feet pipe to convey the sewage beyond Birds island. A petition for the construction of the sewer will be presented to the mayor.

THE HOLLY MANUFACTURING CO. has just secured a contract for the erection of a 20,000,000 gallon pumping engine for the Spring Garden pumping station, at Philadelphia, Pa. The bids made for the supply of this engine were as follows: H. R. Worthington, New York, $57,000; Robert Wetherill & Co., Chester, $67,000; Holly Manufacturing Co., New York, $69,000; Wm. Cramp & Son, Philadelphia, $72, 330; I. P. Morris & Co., Philadelphia, $72,330. According to the Philadelphia *Ledger* the reasons given by Chief Engineer Ogden for the rejection of the lowest priced engine among the bids was that "the high duty attachment was new and of an experimental character," and that the successful competitor included in his bid certain "extras" usually paid for separately by the city. The estimated amount of these 'extras" was $1950. Chief Engineer Ogden further advised a trial of the new "high duty attachment" on a Worthington pump now in the city's possession before buying a new one of the class now required. The usual committee of city councilmen had visited New Bedford and witnessed the successful operation of one of the new pumps here referred to.

BROOKLYN, N. Y.—As the proposed increase of the water supply by means of a ten-mile extension from the present terminus has caused a deadlock between the Board of City Works and the Aldermen, Chief Engineer Van Buren has under consideration, a plan to temporarily bridge over the difficulty at a small cost. His plan is to deepen Watts and Springfield ponds and to establish a pumping station at Baisley's pond, drawing water from the pond and a well to be dug near by. This would probably increase the supply by about 6,000,000 gallons per day.

The extension of the Knickerbocker avenue sewer is now completed. It runs from Thames street to an outlet at the foot of South Fifth street; is 12 feet in diameter and drains an area of about 2,800 acres and materially relieves the Wallabout main sewer. Chief Engineer Van Buren has inspected the work and pronounced it satisfactory; the cost has been $650,000, and it has taken over two years to construct the sewer. The contractors were Edward Freel and Anderson & Barr.

NEWS OF THE WEEK.

Contracting.

Sewer.—H. S. Cousins has been awarded the contract to construct a cement sewer, 4 feet by 12 feet, at Saccarappa, Me., for $4.75 per rod. S. L. Stephenson is the engineer.

Hospital.—The city of Detroit, Mich., are about to erect a new hospital building; the plans and specifications of which are completed, and can be seen at the office of Dr. Wight, and the Board of Public Works, Detroit, Mich. The building will have all the modern improvements.

Y. M. C. A. Building.—The Young Men's Christain Association of Indianapolis, Ind., propose to erect a building on Illinois near Washington street, in that city, three-story, of stone; and will cost about $30,000.

Paving.—The Parkdale, Ont., Council, has awarded contracts for street work as follows, for block paving, per yard; curbing, per foot; and crossing plates per cwt, respectively: Section 1, Richard Dinnis, $1.34½, 22¼ cents, $2.25; Section 2, D. L. Van Vlack, $1.26; 20 cents, $2.50; Section 3, Ardagh & Leonard, $1.25, 22 cents, $2.50.

Designs for University.—Competitive designs for the Succursale of Laval University, Montreal, Canada, will be received until May 1st, 1887; and premiums of $700, $500, and $300 will be awarded. Full information may be obtained of M. E. Methot, President, Quebec Seminary, Quebec.

Cast-Iron Pipe.—The following bids have been received for furnishing Chicago with 12-inch, 8-inch and 6-inch water pipe: Buffalo Cast-Iron Pipe Co., $29.50; Cincinnati and Newport Iron and Pipe Co., $28.97; Dennis Long & Co., $32.00; Ohio Pipe Co., $31.00, (these bids are the same for each size); McNeil Pipe and Foundry Co., $31.50, $31.50, $30.50; Gloucester Iron Works, $35.91, $35.91, $34.09. The contract has been awarded to the Ohio Pipe Co.

Dredging.—The following bids for dredging were opened by Col. Elliott, October 4: Newport Harbor R. I.,—Hartford Dredging Co., Hartford, Conn., 21⅝ cents per cubic yard; Wm. H. Beard, Brooklyn, N. Y., 24 cents; John McDermott, Cohoes, N. Y., 24¾ cents; Elijah Brainard, New York City, 32 cents; R. M. Payn, Albany, N. Y., 34 cents; Frank Pidgeon Dredging Co., New York City; A. B. Martin, Boston, Mass., 39 cents. Wareham Harbor, Mass.,—Frank Pidgeon Dredging Co., New York City, 13.95 cents; E. M. Payn, Albany, N. Y., 17.9 cents; Atlantic Dredging Co., Brooklyn, N. Y. 18 cents; Hartford Dredging Co., Hartford, Conn., 24 cents; John McDermott, Cohoes, N. Y., 24.75 cents; Elijah Brainard, New York City, 25 cents.

Pumping Engine.—Tenders will be received up to November 20th, by the Collector and President, Hyderabad Municipal Commission, Hyderabad, Sind, India, for (1) a compound, direct-acting, centrifugal pumping engine, capacity 120,000 gallons per hour, depth of suction, 23 feet 6 inches, and height of delivery, 16 feet 6 inches; and (2) a loco-multitubular boiler, 8 H. P., large firebox for wood fuel, fire door at side, 80 pounds pressure, to be tested under water pressure to 100 pounds. Also for a horizontal, direct-acting, compound engine to be fitted over a well, double action lift and force pump 15 feet below, to be worked by a rocking arm. Separate bids. Boiler and cylinders to be covered with cement and sheathed in blued steel with brass bands. Engineer, J. Bayliss, Hyderabad, Sind.

Designs for State House.—The Board of State House Commissioners for the State of Kansas will receive plans for the completion of the central portion of the State House at Topeka, up till January 4th, 1887. The plans are to consist of first, second and mezzanine floor plans, with south and east elevations, and transverse and longitudinal sections. Scale, eight feet to the inch; size of plan to be governed by plans of basement story, already adopted, to be seen at the office of the board in Topeka, Kan. The style of architecture must harmonize with the wings already built; and complete specifications must accompany the plans. The board will pay $3,000 for the best, and $1,500 for the second best design, and these designs will become the property of the State. The usual rights are reserved. For particulars address E. B. Allen, secretary of the Board.

Steel Contracts for the Government.—The Navy Department has issued advertisements inviting all domestic manufacturers of steel to specify, in competition, upon what terms they will engage to manufacture the gun forgings and armor plate required for the prosecution of work on ordnance and war ships already authorized by Congress. No bids will be considered except such as engage to produce all the material in this country, and bidders must show that they are in possession of, or have provided for, plant adequate for carrying out the work. Bids may be separate or for both works, but preference will be given to the latter, and they will be compared separately for gun forgings and armor plate. About 1,310 tons of forgings will be required, for guns from 6 inches to 12 inches calibre; and about 4,500 tons of armor plate from 20 feet by 8 feet by 12 inches downward. Information as to shapes, weights tests, etc., may be obtained from the Chief of the Bureau of Ordnance, Navy Department; and bids to be addressed to the Secretary of the Navy, will be received until December 10.

Railroads, Bridges and Canals.

A Philadelphia "L" Railroad.—A company has been organized in Philadelphia to construct a system of elevated railroads. Capital, $6,000,000. President, George H. Baker.

Nicaragua Ship Canal.—The project for this interoceanic ship canal, is likely to be energetically pushed forward during the next session of Congress.

The Merv Railroad.—The Russians are pushing the construction of this road very rapidly. Between Karybent and Merv the rails were laid at the rate of nearly three miles per day. The works were carried on in military fashion, and the officers superintended the work on horseback. Extraordinary expedition was made, the soldiers working with great energy.

Hudson Suspension Bridge and New England R. R. Co.—The engineer's report on the routes for the connections and extensions has been received by the president, W. C. Hurd. The financial arrangements for the construction of the bridge are said to have been satisfactorily completed by the counsel to the company, Robert Sewell.

The Lachine Bridge.—The last caisson has been sunk, and Messrs. Reid and Fleming, the masonry contractors, expect to have their work completed before the contract time. The ironwork is also being proceeded with. The construction of the section from Cote St. Luc to the bridge, is being pushed rapidly under the supervision of Mr. Wm. Daly.

Railroads in France.—At the end of March, 1886, there were 19,064.36 miles of Railroad in operation, as compared with 18,446.25 miles at the same period in the previous year. The State added 41.25 miles of new line to its railrord system during the year ending in March and the six great companies opened new lines as follows: Northern R. R., 65 miles; Southern R. R., none; Eastern R. R., 141.88 miles western R. R., 10.25 miles; Orleans R. R., 137.50 mile and the Paris, Lyons & Mediterranean R. R., 130 miles. The revenue collected upon the whole railroad system for the first quarter of the current year, was $44,186,725, a decrease of $2,631,645 as compared with the corresponding period in 1

Canadian Pacific R. R.—Collingwood Schreiber, chief engineer, has inspected the line from the Pacific to Winnipeg, and reports it in good condition. Substantial snow sheds are being built on the Rocky mountain sections at a cost of $1,500,000.

Thames River Bridge.—The Shore Line has abandoned its project of bridging the Thames near New London, Conn. The soundings showed 35 feet of water and 70 feet of mud. The War Department stipulated for a headway of 32 feet, and as the cost would probably amount to nearly $2,000,000, the company will adhere to the present system of ferriage.

A Railroad Suit.—Suit has been filed in the U. S. Court against the Cresson, Clearfield County & New York Short Line R. R. Co.—a thirty mile coal railroad from Cresson to Irvona, Pa.—by Wm. P. Van Aken, of New York City, to recover $74,000 for work done as subcontractor. The court is asked to annul a mortgage of $750,000 made by the defendants to the American Loan and Trust Company, and to compel the latter corporation, as trustee, to cancel the indebtedness of the defendant company.

Street Railroad.—The construction of the first street railroad in Lockport, N. Y., was commenced October 4th. John Hodge, of Lockport, is president; T. Will Harris, C. E., of 19 Exchange Place, Boston, is the contractor. A 42-pound rail will be used; and the best pine timber for the rail cross-ties and stringers. Wrought-iron gauge rods will be used every 10 feet, and improved wrought-iron knees. Mr. Harris has just finished putting down some street railroads in Cincinnati, O. He makes a specialty of this class of construction.

The Poughkeepsie Bridge.—Conflicting rumors are current in Poughkeepsie, some to the effect that work is to be commenced at once and pushed right along; others that owing to changes made in the plans work will be deferred until the spring. Mr. Clark, of the Union Bridge Co., and Mr. Putnam, an engineer experienced in deep submarine foundations, have been on the site recently. A material change in the design is the substitution of three cantilever spans and two trusses for the former plan for two cantilever spans and three trusses.

Missouri River Bridge.—The contract for the new bridge over the Missouri river at Kansas City, for the Chicago, Milwaukee & St. Paul R. R. Co., has been awarded to the Keystone Bridge Company. The foundations will be sunk by the pneumatic process and the caissons will be 9 feet high, with walls 3 feet thick, and top 8 feet thick. The bridge will be of steel, on the cantilever principle, and will be 80 feet high and 1,300 feet long, with approaches of 200 feet. The plans will be submitted to the Secretary of War, and work will be commenced as soon as they are approved. It will be a magnificent structure. The contract price is $600,000, for substructure and superstructure, but the completed bridge will involve an expense of $1,000,000. The foundations will be constructed by Gen. William Sooy Smith.

Notes of Foreign Railroads.—The Left Rhine R. R. Co. has received an offer from John Cockerill & Co., Seraing, Belgium, to supply 5,000 tons of steel rails at 101 marks per ton, from three to six marks lower than any German offer.—The Mediterranean R. R. Co. has ordered sixteen locomotives from Messrs. Ansaldo, of Sempierdarena, Italy; there will be eight four-coupled engines, fitted with the Westinghouse brake, and eight tank engines fitted with the Henry brake. Deliveries are to be made in 1887.—The Sultan of Persia has authorized the construction of a system of 2,728 miles of narrow gauge lines between the Bosphorus and the Persian Gulf. The estimated cost is about $120,000,000. The main line will run from Scutari through Angora, Kaisaraih and Diabekr, along the Tigris valley to Bagdad and thence to the Gulf across the plain of Babylonia. A syndicate of Paris and Berlin bankers have taken up the scheme, and the Austrian engineer Pressel will be in charge.—The Japanese Government has decided upon placing large orders in England for rails, bridges, locomotives and plant required for railroad extensions which are to be constructed at once.—The Congo Railroad scheme has been abandoned owing to disagreement between the syndicate and the King of the Belgians.—The Brazil Great Southern R. R. Co. has completed its line from Quaranim to Uruguayana, a distance of fifty-two miles.—A railroad is to be built from La Paz, Bolivia, to the Pacific coast.—The Buenos Ayres & Pacific R. R. Co. has acquired the concession from the Argentine Republic for a line from Mercedes to Buenos Ayres, and has entered into negociations with Messrs. Clark, the contractors, for its construction.—W. S. B. McConnico, of New Orleans, La., proposes to to build a railroad in Honduras along the coast between the ports of Trujillo and Puerto Cortez, a distance of 150 miles.—The Mexican Government has declared forfeited the concessions for railroads from Apizaco to Huanchin, and from Tijuana, on the American frontier, through Punta Isabel to the Sonora R. R.

Contractors Intelligence,

Reported by T. H. Boorman.

Engineering and Building Materials,

WHOLESALE PRICES.

New York, October 7, 1886.

IRON.

STRUCTURAL IRON.		
Angles	2.15c	@ 2.30c
" steel	2.40	@ 2.50
Tees	2.50	@ 2.60
Beams and channels, American	3.0	@
Tank plates	2.25	@ 2.35
Shell plates	2.50	@ 2.60
Steel plates, Tank	2.70	@ 2.75
WROUGHT-IRON PIPE, PITTSBURG.		
Butt welded, black ... Discount		42½
" " galvanized ... "		32½
Lap welded, black ... "		55
" " galvanized ... "		37½
Boiler tubes ... "		47½
RAILS.		
Steel (large lots at mill)	$34.00	@ $35.00
Old rails	22.50	@ 22.50
Old rails, steel	22.00	@ 23.00
	2.15c	@ 2.25c
R. R. spikes	1.75	@ 1.90
R. R. spike-plates	2.50	@ 2.75
R. R. track bolts, square nuts	3.85	@ 3.90
Barb-wire fencing, galvanized		4.00
" " painted		
Corrugated iron		
Nails		
Iron, per keg	2.00	@ 2.10
Steel do.	2.10	@ 2.20

METALS.

COPPER.		
Lake Superior	11.00	
Other Brands	11.05	@ 11.45
LEAD.		
Com. Domestic	4.30	@ 4.40
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	5.½	@ 5¾

BRICK.

Cargoes (afloat)		
Choice Brands	7.50	
Haverstraw ... per M.	6.62½	@ 7.50
Fishkill	6.75	@ 6.87½
Up-River	6.00	@ 6.62½
Jerseys	5.75	@ 6.50
Long Island		
Pale	4.50	@ 4.87½
FRONTS.		
Croton, red	11.00	@ 15.00
" dark	11.00	@ 15.00
" brown	10.00	@ 14.00
Philadelphia pressed	27.00	@ 28.00
Trenton "	25.00	@ 26.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	85.00	@ 130.00
" American	80.00	@ 120.00
Fire brick	25.00	@ 55.00
" American, No. 1	30.00	@ 35.00
" " No. 2	25.00	@ 30.00

ASPHALT.

ROCK.		
French, per ton	$20.00	@ 25.00
German	15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50	@ $3.00

LIME.

Rocklock Cement Co.'s Ground	.80
Rockland, common per bbl	1.00
" finishing	1.20
State, common	.85
" finishing	1.05
Kingston, ground	.90
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95	@ 1.00
" " No. 2 "	0.75	@ 0.85
" " light drab "	0.80	@ 0.95
Berlin " in rough "	0.75	@ 1.00
Berea " "		
Brown stone, Portland, Ct. "	1.00	@ 1.35
" Belleville, N. J. "	0.75	@ 1.35
Granite, rough	0.45	@ 1.25
Common building stone per load	2.00	@ 3.00
Sawed stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@ 3.00
Concrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square	6.00	@ 7.00
Green "	6.00	@ 7.00
Red "	15.00	
Black Penna. (at New York) "	4.50	@ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00	@ 20.00
Choice "	65.00	@ 70.00
Tally plank, 1¼ in. 10 in. dress'd, each.	.44	@ .50
Tally boards, dressed com. "	.28	@ .30
SPRUCE, Boards dressed "	.25	@ .28
Plank, 1¼ in "	.28	@ .30
" 2 in. "	.38	@ .40
" 2 in. dressed "	.43	@ .45
Timber per M.	14.00	@ 18.00
HEMLOCK, Boards each.	.18	@ .20
Joist, 2¼ × 4 to 4 × 6 in	.16	@ .44
OAK per M.	55.00	@ 65.00
CYPRESS 1, 1¼, 2 and 2¼ in	35.00	@ 40.00
YELLOW PINE, Girders "	26.00	@ 30.00
Dressed flooring "	28.00	@ 35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75	@ 6.00
LATH, Cargo rate "	2.35	@ 2.40

PAINT.

Lead, white, American dry per lb	.04¼	@ .06¼
" " " in oil pure	.07	@ .07½
" English, B. B. in oil	.08¼	@ .09¾
" Red, American	.06¾	@ .07
Litharge "	05½	@ .06
Venetian red, American "	.01	@ .01¼
Indian red "	.08	@ .10
Vermillion, American lead "	.10½	@ .11½
Paris green "	.15	@ .18
Umber, Amer. raw and powdered per lb.	.01¼	@ .01¾
Drop black, Amer.	.07	@ .13
" " Eng.	.11	@ .13
Chrome green	.10	@ .25
Oxide zinc, American	.03¾	@ .03½
" French	.06½	@ .07½

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement		$1.10
BAETJER & MEYERSTEIN:		
Hanover Portland	$2.60	@ $2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25	@ 2.50
Fewen	2.25	@ 2.50
BROOKS, SHOOBRIDGE & Co.	2.45	@ 2.60
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs	2.50	@ 2.75
K. B. & S. " "	2.25	@ 2.50
Stettiner, German	2.65	@ 2.85
Lagerdorfer, "	2.45	@ 2.75
Fieve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.45
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
NEW YORK CEMENT Co.:		
Rosendale		1.10
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BAUSON:		
Alsen's Portland Cement Works	2.35	@ 2.85
K. B. & S.	2.25	@ 2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT Co.:		
English Portland	2.25	@ 2.40
German "	2.00	@ 2.15
Standard	1.80	@ 1.65
Windsor and Improved Rosendale	1.00	@ 1.10
UNION AKRON CEMENT Co.:		
Akron "Star" brand	1.00	@ 1.10

MARKET SUMMARY.

The Brick Market has stiffened and a good business doing at the advance in rates. Pa es have been sold at $6.50@$6.67½ per M.; Haverstraws $6.62½@6 67½, with choice quality at $7@7.50 per M.; Up-rivers are in demand at $6@6.87½, with Fishkills selling at $6 75@$6.87½, the latter being in request, the quality of the clay and make of many of the manufacturers at that place being preferred to some of the Haverstraw brands; Croton fronts in good demand at last quotations; other brands also in request without change in rates. There is a much better demand for Rosendale Cement which is selling at $1@$1.10 per barrel, with large sales reported at the latter quotation; Portland Cement moves readily at prices according to brand and size of invoice. Lime has arrived to only a limited extent, but several vessels are just in and prices are unaltered. The Lumber Market is without change. Spruce is firm at last week's rates of $14@$15 per M. for random and $16@18 for special cargoes; Lath has sold readily a $2.35 for good quali y Spruce, and quotations close at $2.35@$2.40 per M.; Yellow Pine, random cargoes, $18@19 50, special cargoes, $19.50@$12 per M ft. Hardwoods are without change; White Ash, $35@40; Oak $30@40; Maple, $20@32. Paint and Oil show no change. Turpentine is slow of sale and a fraction lower, present quotations being 37½c. per gallon. The Hardware Market is a little more lively, but prices are unchanged. Nails are selling at $2@$2.10 per keg for 10d to 60d, according to size of invoice; Pig Lead has weakened and about 150 tons reported sold at 4½c., with the market unsettled and hesitation among buyers to make bids; Pig Iron has also weakened and Straits have declined about ½c., with but little demand for consumption; Tin Plate is in fair demand and prices ste dy; spot quotations are for I. C. Charcoal, ½ cross assortment, $4.65 for Allaway, and $5.15@$5.40 for Molyn grade; Zinc is quoted at 5½c.@5¾c. per pound, and Solders, 15c.@15½c. for half and half, and 14c.@14½c. for extra. Pitch and Tar are dull, the former at $1.80@$1.90 per barrel, the latter at $1.90@$2.40 per barrel.

BUILDING ITEMS.

Mr. C. C. Haight is the architect for an extension to cost $30,00 to be added to the new Cancer Hospital on 106th street, near Eighth avenue. Mr. Isaac A. Hopper has the contract, for the mason work.

Mr. J. C. Barns has designed ten five-story brick flats to be built on Eighth avenue, 127th and 128th streets, for Mr. John W. Hasten, at a cost of $220,000.

Mr. Robert Mook has made plans for alterations to be made to the building on the northwest corner of First avenue and 26th street, which will cost $60,000. Mr. A. T. Kruse, agent of property.

Messrs. George E. Harding & Dinkelburg have on hand plans for a one-story brick iron-foundry, 50x100, to be erected for Mr. Collins at Bloomfield, N. J., at a cost not yet estimated.

Messrs. George Mathias & Co., Stewart building, are preparing plans for two five-story brick and stone tenements, 25x83, to be built for Mr. Wm. A. Juch on the south side of 89th street, between Second and third avenues, at a cost of about $45,000.

Messrs. Berg & Clark, 152 Fifth avenue, have on the boards plans for five three and four-story and basement brick and stone dwellings, 20x45 each, to be built on the south side of 72nd street, near West End avenue, at a cost of $25,000.

Mr. C. H. P. Gilbert, 18 Broadway, has designed for Wm. H. McCormack three four-story brick, stone and terra-cotta residences, 19, 20 and 21 feet fronts, by a uniform depth of 57 feet, to be built on the south side of 72nd street, west of the Boulevard.

Mr. Hy. F. Kilburn has designed two residences to be built at Larchmont, N. Y., to cost $8,000 each, one for Mr. Wm. Murray and the other for Mr. Byron Ford.

Mr. Chas. Baxter has prepared plans for six three-story and base ent, brick, stone and terra-cotta residences, four 17 feet fronts and two 16 feet by a uniform depth of 50 feet, to be built at a cost of $57,000, on the north side of 93th street, 150 feet west of Ninth avenue for Mr. W. S. Jennings.

Mr. A. E. Hudson is the architect for a country hotel, 48x125, to be built for R. Ringo, of New York, at Saratoga, N. Y., at a cost of about $12,000.

Messrs. Rand & Taylor, of Boston, have been awarded the first prize in the competition of designs for the Town Hall to be erected at Winchester, Mass.

Mr. W. M. Grinnell has on the boards plans for two residences to be built at Audubon Park for Messrs. W. D. Page and Newell Martin; they will cost $20,000.

Messrs. D. & J. Jardine, 1262 Broadway, report that they have on the boards plans for a residence of stone, brick and frame to be built at Yonkers, N. Y., for Mr. Wm. B Ketcham.

Among the buildings about to be started in Brooklyn are the following: George Phillips, three three-story dwellings on Hancock street, east of Nostrand avenue, to cost $42,000; John Teafe, five two-story dwellings on Sterling Place, east of Sixth avenue, to cost $30,000; Thomas Stowe, two five-story apartment houses on State street, east of Bond, to cost $17,000; Booth & Cameron, four three-story dwellings on Decatur street, near Louis avenue, to cost about $30,000; Weeks & Lauer, ten two-story dwellings on Palmetto street, east of Hamburg avenue, to cost $20 000; Charles H. Collins, two three-story dwellings on St. Mark's avenue, west of Sixth avenue, to cost about $12,000.

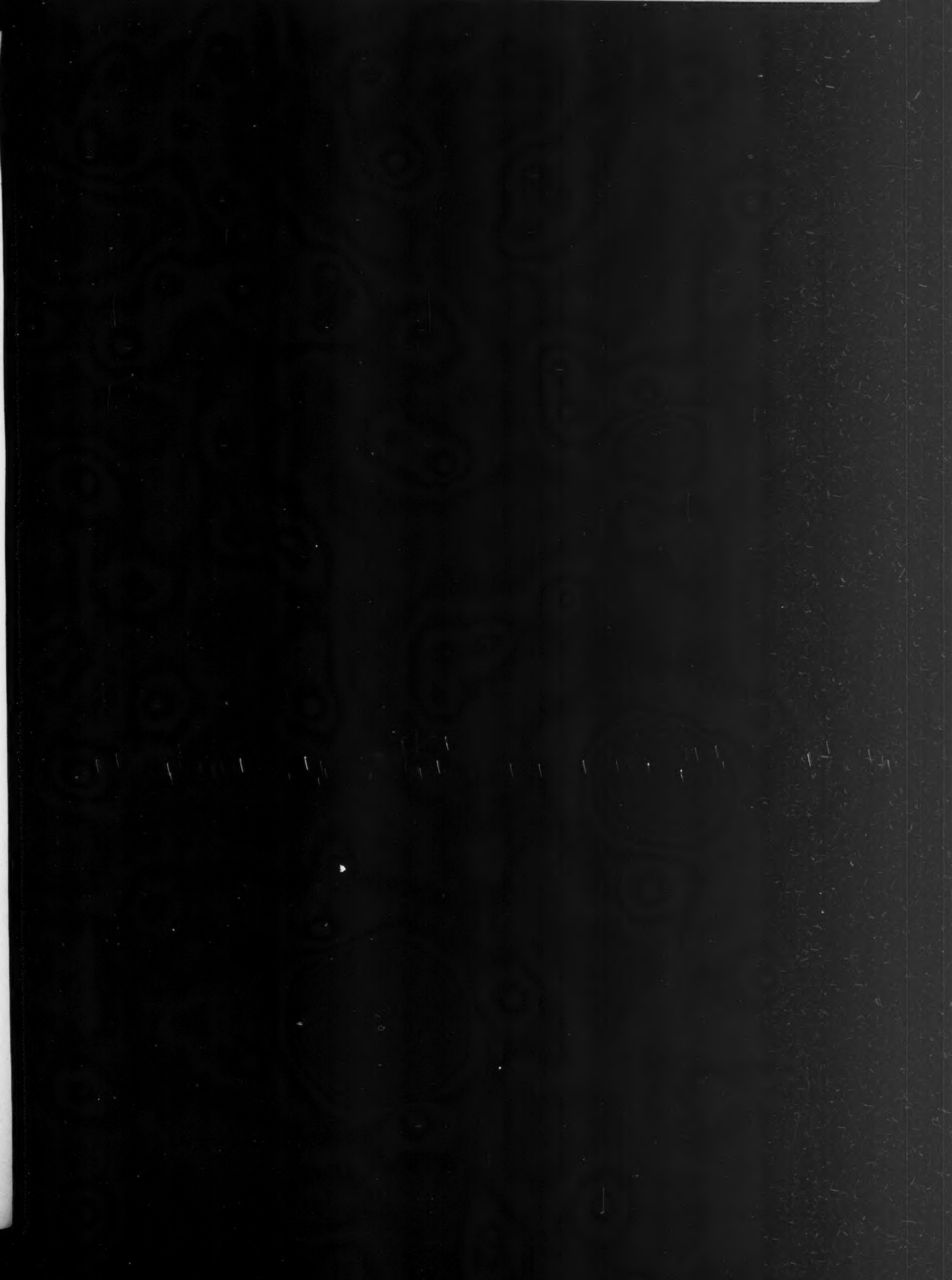
Messrs. C. Abbott French & Co. report plans on hand for the alteration of the stable on the northwest corner of 58th street and Seventh avenue into a riding academy for Messrs. Emile an t Dilhom, at a cost of $5,500, also plans on the boards for a four-story hotel, 55x108, to be built in the Queen Anne style, for Mr Humphrey at Tarrytown Heights, at a cost of about $23,000.

The records of the Bureau of Buildings show that during the month of September plans were received for the erection of 357 buildin gs, of the estimated value of $4,019,760. During the quarter ending with September 30th, plans for 1,018 buildings were received, of the estimated cost of $12,284,455. The total number of buildings projected during the year 1885 was 3,368, of the value of $45,374,013, and during the nine months of the present year the plans numbered 3,440, and the estimated value was $30,040,148.

The contract for the new building, to be erected for the Clarks Thread Co. at Newark, N. J., has been awarded to Mr. Chas. T. Wills, of this city.

Mr. Percy Griffin, 206 Broadway, reports plans on the boards for a three-story and attic residence, 40x70, to be erected for Mr. C. D. Newell, at Orange, N. J., also plans for a $3,000 cottage, to be built at the same place.

Work has commenced on the excavations for the building, to be erected for the employees of the New York Central Railroad by Cornelius Vanderbilt. The contract for the erection has been awarded to James B. Smith. Messrs. R. H. Robertson and A. J. Manning are the associated architects.

MANGANESE IN RUSSIA.—The production of manganese in Russia is increasing steadily, according to a lately-published report. The exports for the first four months of 1886 amounted to 9,000 tons, as against 4,500 tons for the corresponding period of 1885. It appears that with better means of conveyance than at present exist the exports might be largely increased. Only large lumps of ore can be carried by the conveyance from the mines at Tchiatoor to the Trans Caucasian Railway, by which the ore is brought to Poti, where it is shipped. The smaller pieces of ore, amounting, it is said, to two-thirds of the total quantity extracted, are thus wasted, though equal in quanlity to that exported.

NOTICE TO BRIDGE CONTRACTORS.—The Kansas City, Wyandotte and Northwestern Railroad Company will receive bids at its office at Wyandotte, Kan., for its bridge and trestle work. For specifications and particulars apply to Martin Kelly, Wyandotte, Kan.